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# Stabilization Investigation

## Former CIBA-GEIGY Facility
## Cranston, Rhode Island



## *Revised Final Stabilization Design Documents*

**Operational Performance Standards/Performance Monitoring**
**Shut-Down Criteria/Confirmatory Sampling Plan**
**Project Management**

**Prepared For:**
**CIBA-GEIGY Corporation**
Route 37 West
Toms River, New Jersey 08754

**Prepared By:**
**Woodward-Clyde Consultants**
201 Willowbrook Boulevard
Wayne, New Jersey 07470

Volume 1 of 4

January 1995
Project No. 87X4660D

**Regional Remediation Team**

Ciba-Geigy Corporation
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Telephone 908 914 2500
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January 27, 1995

Mr. Frank Battaglia, Project Manger
United States Environmental Protection Agency - Region I
90 Canal Street, Waste Management Building
Boston, Massachusetts 02114

**REF: REVISED FINAL STABILIZATION DESIGN DOCUMENTS**
**CIBA-GEIGY SITE- Cranston, Rhode Island**

Dear Mr. Battaglia:

Ciba, and Woodward-Clyde Consultants, are pleased to submit the revised Final Stabilization Design Documents (FSDD) and our responses to the EPA comments on the FSDD (see Attached). The revisions were driven by changes to the groundwater pretreatment system, which are fully described in Subsection 2.3 of Volume 1, Stabilization Investigation. Subsequent changes were made to report volumes 2,3 and 4 to reflect this revision. We also addressed EPA's comments when making the revisions.

The implementation schedule for the Stabilization Systems shown in Figure 6.2 of Volume I should remain the same, with startup occurring in early August 1995. We wish, however, to bring to your attention the Interim Remedial Measure (IRM) for the Production Area and the Warwick Property which is planned for May through June 1995. If for any reason, there are delays in the PCB soil removal in the Production Area, it may affect the implementation of the Stabilization Systems.

**Volume 1, Stabilization Investigation** - Operational performance standards, performance monitoring, shut-down criteria and confirmatory sampling plans for the three stabilization systems including a project management section.

**Volume 2, A and B Technical Specifications** - (divisions 1 through 16) for construction of the stabilization systems.

**Volume 3, Operation and Maintenance (O&M)** - Manual for the stabilization system.

**Volume 4, Design Drawings** - For the construction of the stabilization systems are presented.

Very truly yours,

Barry J. Berdahl

Barry J. Berdahl, Ph.D., C.H.M.M.
Regional Compliance Manger

cc: Mayor M. Traficante, City of Cranston
Mr. A. Tutela, P.E., Tutela Engineering Associates
Mr. J. Unsworth, RIDEM

**Woodward-Clyde**

Engineering & sciences applied to the earth & its environment

January 27, 1995
87X4660D, D11

Mr. Frank Battaglia
United States Environmental Protection Agency - Region I
Waste Management Building
90 Canal Street
Boston, Massachusetts 02114

**Re: Final Stabilization Design Documents - Responses to Comments Former CIBA-GEIGY Facility - Cranston, Rhode Island**

Dear Mr. Battaglia:

Woodward-Clyde Consultants (WCC) and CIBA have reviewed your comment letter dated September 29, 1994 on the FSDD submitted in June. Responses to Comments A through D were submitted to your office on October 21, 1994 along with the proposed design modifications and revisions to the groundwater pretreatment system. Responses to comments No. 1 through 47 are presented here:

Comment No.

1. The Final Stabilization Design Documents were required to be submitted in June 1994. The document as submitted contains a number of issues which require further clarification. Many of the issues are of minor consequence individually, but render the package as a whole to be unsuitable for bid purposes. The designs need to be subjected to finalization by the facility including a thorough review and final approval by supervising design professionals. EPA will not be involved in the review or approval of the final bid package.

*Response:* *The revised FSDD Package addresses the above concerns raised by the USEPA.*

2. The suitability of the use of existing equipment, such as the air stripper and sand filter, cannot be confirmed without the equipment specifications. Ciba-Geigy should assess the suitability of existing equipment in treating specific site contaminants at the design mass loading rates prior to developing the bid package, since these unit processes are central to the success of the groundwater treatment system.

*Response:* *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised. The existing air stripper and sand filter have been removed from the groundwater pretreatment system.*

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3. Technical specifications must be provided for the sand filter, air strippers, and the Lift Station No. 3 sump. EPA had previously requested the addition of these specifications in Comment No. 4 of the March 16, 1994 letter to Ciba-Geigy.

Response: *This comment is no longer applicable for the sand filter, air strippers, and the Lift Station No. 3 sump; the design of the groundwater pretreatment system has been revised. Information on the existing activated carbon adsorption system is presented in Appendix A of Volume 2.*

4. EPA's Comment No. 12 in the March 16, 1994 letter was not completely addressed with respect to an additional nozzle to accommodate the flow streams entering the air oxidation tank from the two (2) equalization tanks. Drawing M4 indicates that the effluent from both equalization tanks combine prior to entering the air oxidation tank. Drawing I4 indicates that the oxidation tank has inlet nozzles for both streams. The drawings and specifications should be corrected based upon the design that is intended.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised. The two equalization tanks have been replaced with one small equalization tank and the air oxidation tank has been removed from the groundwater pretreatment system.*

5. The Table of Contents is not representative of the information contained within the Technical Specifications. The following non-referenced sections are contained in the Technical Specifications, and should be added to the Table of Contents:

A. Section 01040 - Coordination
B. Section 01590 - Temporary Constructed Facilities
C. Section 02800 - Fencing
D. Section 11300 - Vertical Submersible Recovery Well Pumps
E. Section 11350 - There are two sections with this number: Horizontal Centrifugal Pumps, and Vapor Phase Treatment System. One should be changed to reflect a new section.
F. Section 11375 - Centrifugal Blowers
G. Section 11400 - Activated Carbon Adsorption Systems
H. Section 13415 - Functional Specification
I. Section 13420 - Miscellaneous Instruments and Control Devices
J. Section 13460 - Control Program Hardware
K. Section 15140 - There are two sections with this number:Pipe Hangers,

Supports, and Restraints, and Supports and Anchors. One should be changed to reflect a new section.
L. Section 15060 - Soil Vapor Extraction Piping and Appurtenances
M. Section 15260 - Piping Insulation
N. Section 15400 - Compressed Air Equipment
O. Section 15821 - Dehumidifier
P. Section 15880 - Ductwork and Accessories
Q. Section 15980 - Instrumentation and Controls

Response: *Agreed. The Table of Contents and noted specification sections has been revised.*

6. Page 01620-1, ¶ 1.3A: Reference is made to Section 03250. This section was not provided in the document. Revise the document to state the correct reference or provide Section 03250.

Response: *Agreed. The reference has been changed to Section 05505, "Anchor Bolts, Expansion Anchors and Concrete Inserts".*

7. Page 01620-1, ¶ 1.3B: Section 03600, referencing "grouting procedures", was not provided in the document. This line should be replaced with Section 03010, "Grout."

Response: *Agreed. The reference has been changed to Section 03010, "Grout".*

8. Page 11212-2, ¶ 2.1.A: The 0.75-inch discharge for the sludge recycle pump was increased to 2-inches rather than 1.5-inches, as requested in Comment No. 5 of EPA's March 16, 1994 letter. Similarly, the 1-inch inlet for the sludge transfer was increased to 3-inches rather than 2-inches and the 1.5-inch inlet for the filter press feed pump was changed to 2-inches rather than 3-inches, as requested by EPA. Indicate the rationale for not implementing the requested changes or revise the document to address EPA's March 16, 1994 comments.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised. The sludge handling system has been removed from the groundwater pretreatment system.*

9. Page 11214-2, ¶ 2.1.A.1: The percentage of sodium hydroxide in the caustic feed was not changed from 25% to 20% as requested by EPA in Comment No. 6. It should be changed for consistency.

Response: *Twenty-five percent sodium hydroxide (NaOH) is currently available from the local chemical supplier and will be used for pH control instead of the originally noted twenty percent NaOH.*

10. Page 11226-4: The sludge drain nozzle was increased from 1.5-inches to 2-inches rather than 3-inches, as requested by EPA in Comment No. 8 of the March 16, 1994 letter. Indicate the rationale for not implementing the requested changes or revise the document to address EPA's comment.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised. The sludge handling system has been removed from the groundwater pretreatment system.*

11. Page 11247-1, ¶ 1.2.4: Reference is made to Section 13000, "Plant Monitoring and Control System". The Table of Contents refers to "Plant Monitoring and Control System" as Section 13400. In addition, this section was not provided in the document. Revise the document to clarify if "Plant Monitoring and Control System" is Section 13000 or 13400, and provide the section.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised. The liquid polymer feed system has been removed from the groundwater pretreatment system.*

12. Page 11300-1, ¶ 1.2.A.1: Reference is made to Section 13400. Refer to Comment No. 11, above.

Response: *Agreed. The reference has been changed to Section 13410, "General Instrumentation and Control Requirements.*

13. Page 11350-1, ¶ 1.2.B: Reference is made to Section 11340, "Soil Vapor Extraction Equipment". This section is not included in the document. Indicate whether "Soil Vapor Extraction Equipment" information is provided in Section 11400, "Activated Carbon Adsorption Systems", and Section 11210, "Soil Vapor Extraction Pumps" or revise the document to include Section 11340.

Response: *Agreed. Section 11340, "Soil Vapor Extraction Equipment" has been added to the Technical Specifications.*

14. Page 11350-2, ¶ 2.1.A: TDH values are not provided in the chart for the referenced transfer pumps. These values should be provided.

*Response:* *Agreed. Total dynamic head (TDH) values have been provided in Section 11351 (changed from Section 11350) for the horizontal centrifugal pumps.*

15. Page 11400-1, ¶ 1.2.2: Reference is made to Section 13400. See Comment No. 11, above.

*Response:* *Agreed. The reference has been changed to Section 13410, "General Instrumentation and Control Requirements.*

16. Page 13121-1, ¶ 1.2.A: Reference is made to Section 11340. See Comment No. 13, above.

*Response:* *Agreed. Section 11340, "Soil Vapor Extraction (SVE) System Equipment" has been added.*

17. Page 13200-1, ¶ 1.2.A: Reference is made to Section 11340. See Comment No. 13, above.

*Response:* *Agreed. Section 11340, "Soil Vapor Extraction (SVE) System Equipment" has been added.*

18. Page 13200-1, ¶ 1.2.B: Section 9L, "Paint", does not exist. Revise the document to indicate that "Paint" is Section 09900.

*Response:* *Agreed. The reference has been changed to Section 09900, "Paint".*

19. Page 13201-5, ¶ 5.e.: The Pump Suction nozzle is listed as a 4-inch nozzle. EPA's Comment No. 12 in the March 16, 1994 letter requested that the 4-inch pump suction be replaced with a 6-inch nozzle. Indicate the rationale for not implementing the requested change or revise the document to address EPA's comment.

*Response:* *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised.*

20. Page 15400-1, ¶ 1.2.2: Reference is made to Section 13400. See Comment No. 11, above.

*Response:* *Agreed. The reference has been changed to Section 13410, "General Instrumentation and Control Requirements.*

21. Page 15980-1, ¶ 1.2.A: Reference is made to Section 11340. See Comment

No. 13, above.

Response: *Agreed. Section 11340, "Soil Vapor Extraction (SVE) System Equipment" has been added.*

22. Page 16010-1, ¶ 1.2.2: Reference is made to Section 13000, Electrical Work. This Section is not listed in the Table of Contents, nor is it provided in the document. Revise the document to accurately reference the correct section, or provide this Section 13000, Electrical Work.

Response: *Agreed. The reference has been changed to " under Division 13".*

## O&M Manual

23. Page 3-10 - Air Stripping: EPA Comment No. 17 was inadequately addressed with respect to the addition of a second air stripper to the equipment design. The document indicated that an additional air stripper would be added if influent rates exceeded 90 gpm. Most of the equipment is sized for flow rates of 180 gpm based upon the future installation of two additional recovery wells. In order to provide consistency, this should be resolved and the document revised.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised. The air stripper has been removed from the groundwater pretreatment system.*

24. Page 3-13, Part 1 - Dehumidification: The direction of the effluent from the dehumidifier is not specified in the support documentation. Drawing I10 indicates that it returns to Equalization Tank No. 1. This information should be incorporated into the mechanical drawings and all supporting documentation.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised. The dehumidifier has been removed from the groundwater pretreatment system.*

25. This section does not address the system operation and potential problems associated with the soil vapor extraction system. Specifically, the following were not addressed: the liquid and vapor extraction tanks, the liquid and vapor manifold piping, and the thermal oxidation unit. Revise this section to address these omissions.

*Response:* *Agreed. The section has been revised to include the soil vapor extraction (SVE) system.*

**Section 7 Functional Specifications**

26. This section does not provide discussion on several pieces of equipment. The document should be revised to discuss the following pieces of equipment: vapor extraction tank and manifold, liquid extraction tank and manifold, thermal oxidation unit, Lift Station No. 3, sludge holding tank, sludge filter press, and gas activated carbon unit.

*Response:* *Agreed. The section has been revised to address these issues.*

27. Part 1.04 ¶ D: P&ID I1 does not present the process schematic for the pumping wells and the groundwater extraction system. The referenced document should be changed to P&ID I2A and I2B.

*Response:* *Agreed. The section has been revised to address these issues.*

28. Part 1.04 ¶ D.1.b: Electrical Actuators ZY110 and ZY120 are not depicted on P&ID I2A or 2B. The referenced locations may represent YY110 and YY120. The two documents should be checked for consistency and revised accordingly.

*Response:* *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised.*

29. Part 1.04 ¶ E: P&ID I2 does not illustrate the process flow schematic for the equalization tanks. Revise the document to include P&ID I2 and I3 as the referenced drawings.

*Response:* *Agreed. The section has been revised to address this issue.*

30. Part 1.04 ¶ F: Revise the document to change P&ID I3 to P&ID I4 to correctly illustrate the air oxidation and Ph adjustment processes.

*Response:* *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised.*

31. Part 1.04 ¶ F.1.a: The process references the addition of 20% sodium hydroxide. Section 3 of this document, page 3-8 references the addition of 25% sodium hydroxide. The two identified sections should be

corrected for consistency.

Response: *Agreed. The document has been revised to indicate 25 percent sodium hydroxide.*

32. Part 1.04 ¶ G.1.b: The Lamella Clarifier is denoted as T-500 in the text. P&ID I5 denotes T-500 as an inclined plate separator. Clarify which unit is actually designated as T-500. The document and drawing should be revised to use the same equipment terminology for consistency.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised.*

33. Part 1.04 ¶ H.1.c: LT-610, which is identified in the document, is not identified on the referenced figures. The location of the level transmitter in the figures is likely LE-610 or LIT-610, but this requires clarification. The appropriate terminology should be checked and the document and figures changed for consistency.

Response: *Agreed. The document section has been revised to address this issue.*

34. Part 1.04 ¶ k.1.c and k.1.d: The equipment pieces discussed in this section are not explicitly identified. Revise the document to replace all "XXX" denotations with the appropriate equipment numbers.

Response: *Agreed. The document section has been revised to address this issue.*

## <u>Volume 4 - Drawings</u>

35. EPA's Comment No. 19 in the March 16, 1994 letter requested that pipeline and nozzle sizes be added to the drawings. In general, these items still need to be addressed on many drawings, specifically in Sections M and I, which contain process flow diagrams. Revise the drawings to include this information.

Response: *Agree. The mechanical and instrumentation drawings have been revised to indicate pipeline and nozzle sizes.*

### Drawing M1A

36. The sludge recycle stream is shown entering the aeration tank. Other

drawings in Sections M and I indicate that the recycle stream actually enters the flash zone of the gravity settler. Clarify this discrepancy and revise the drawing accordingly.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised.*

37. The Vapor GAC should be depicted by two tanks in parallel rather than a box. Revise the drawing to reflect this situation.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised.*

38. The drawing does not depict how the condensate from the dehumidifier is managed. Drawing I10 provides information on this matter. Refer to Drawing I10 and revise Drawing M1A to specify how the condensate is managed.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised.*

**Drawing M6**

39. Section B: The arrows identifying the sectional cut are not clearly represented with respect to the location of Lift No. 2. Redraw the arrows to identify the sectional cut.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised.*

**Drawing M7**

40. Section E: Based on the sectional cuts depicted on Drawing M4, the sand filter should be included on this drawing. Revise the drawing to include the sand filter unit.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised.*

41. Section H: This sectional cut is not listed on Drawing M5. Revise this drawing to indicate the correct sectional cut, or revise Drawing M5 to list this sectional cut.

Response: *Agreed. The drawing has been revised to address this issue.*

42. Section J: The dehumidifier is not represented in the drawing of the existing Air Stripper. Revise this section of the drawing to include the dehumidifier.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised.*

**Drawing I2B**

43. The recovery well identified as "PW110" is incorrectly identified. Revise the drawing to indicate that this recovery well is "PW120."

Response: *Agreed. The drawing has been revised to address this issue.*

**Drawing I4**

44. This drawing depicts the effluent lines from equalization tanks as entering the Aeration tank separately. Drawing M5 depicts the lines as joining together prior to entering the aeration tank. Revise the drawings to address this discrepancy and depict the correct design.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised.*

**Drawing I10**

45. A drawing of the Vapor-Phase Treatment System, including the dehumidifier and vapor-phase activated carbon unit, is included on drawing I10. More detail is needed with regard to pipe sizing and fittings. Revise the drawing to include this information. In addition, include said information in the mechanical drawings.

Response: *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised.*

46. There are two drawings identified as I10. One drawing should be assigned a new number.

Response: *Agreed. The instrumentation drawings have been revised and renumbered.*

47. The figure should describe the Vapor-Phase GAC in more detail, including the size of piping, type of piping, fittings, and other control instrumentation. Revise the drawing to include said information.

*Response:* *This comment is no longer applicable; the design of the groundwater pretreatment system has been revised.*

If you have any questions or require additional information, please feel free to call us.

Very truly yours,

Joseph J. Corrado, P.E.
Manager, Process and Design Engineering

KAK

Mark Houlday
Project Manager

c: Dr. Barry Berdahl, CHMM - CIBA, Toms River
George Jankov - CIBA, Toms River

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# Stabilization Investigation

## Former CIBA-GEIGY Facility
## Cranston, Rhode Island

*Revised Final Stabilization Design Documents*

**Operational Performance Standards/Performance Monitoring**
**Shut-Down Criteria/Confirmatory Sampling Plan**
**Project Management**

**Prepared For:**
CIBA-GEIGY Corporation
**Route 37 West**
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**201 Willowbrook Boulevard**
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Volume 1 of 4

**January 1995**
**Project No. 87X4660D**

## VOLUME 1

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## LIST OF FIGURES



## LIST OF APPENDICES

# 1.0
# INTRODUCTION

## 1.1 OVERVIEW

These Revised Final Stabilization Design Documents (FSDD) present the work performed during the design phase of the stabilization investigation being conducted at the former CIBA-GEIGY Corporation facility in Cranston, Rhode Island. This chapter presents background information and the organization of the FSDD in four sections:

- Section 1.2 presents background information on the facility, the project, and the stabilization investigation;
- Section 1.3 presents the objectives of the stabilization investigation;
- Section 1.4 presents the contents and organization of the FSDD; and
- Section 1.5 summarizes this chapter.

## 1.2 BACKGROUND

This section reviews briefly the histories of the facility, the project, and the stabilization investigation. More detailed information on the histories of the facility and the project was presented in Chapter 1 of the Phase I Interim Report (submitted in November 1991).

### 1.2.1 History of the Facility

The Alrose Chemical Company manufactured chemicals at the site starting in 1930. After the GEIGY Chemical Company of New York purchased the facility in 1954 and merged with the Ciba Corporation in 1970, the facility was used for batch manufacturing of organic chemicals. Agricultural products, leather and textile auxiliaries, plastics additives, optical brighteners, pharmaceuticals, and bacteriostats were manufactured at the facility. By May 1986, CIBA-GEIGY had ceased chemical manufacturing operations at the facility and had begun decommissioning and razing the plant.

The site is divided into three study areas - the Production Area, the Waste Water Treatment Area, and the Warwick Area. The boundaries of these three areas are shown in Figure 1-1. The Pawtuxet River (an off-site area) runs through the facility. Twelve solid waste management units (SWMUs) and two areas of concern (AOCs) were identified at the site. For completeness, CIBA-GEIGY identified two additional areas of investigation (AAOIs); based on the Phase I results, AAOI-16 has been designated as SWMU-16. The locations and the Media of Concern to be sampled in each of these SWMUs, AOCs, and AAOIs are shown in Figure 1-1. Additional details about these SWMUS, AOCs, and AAOIs were presented in Chapter 1 of the Phase I Interim Report and are summarized in Table 1-1.

### 1.2.2 History of the Project

A draft Administrative Order of Consent (hereafter simply called the "Order") requiring a RCRA Corrective Action Study at the facility was issued to CIBA-GEIGY on 30 September 1988. After negotiations and evaluation of public comments, the Order was signed by CIBA-GEIGY on 9 June 1989 and became effective on 16 June 1989. In 1987, USEPA conducted the Facility Assessment to identify known and/or suspected releases at the facility requiring further action. The results were presented in the Final RFA Report, CIBA-GEIGY RCRA Facility Assessment (January 1988). In 1988, CIBA-GEIGY conducted a Preliminary Investigation (not required by the Order) to begin characterizing the facility's environment and selected releases; the results were summarized in the Current Assessment Summary Report (March 1990).

The RCRA Facility Investigation will characterize the impact of known and/or suspected releases that were determined by the Facility Assessment to require further action. The Facility Investigation is being conducted in two phases; Phase I was conducted in two parts (Phases IA and IB) to obtain additional guidance from USEPA throughout the project. Phase IA was conducted in late 1989 and mid-1990 to characterize the facility's physical environment more completely; the results of Phase IA were presented in the Phase IA Report (October 1990). Phase IB was conducted in late 1990 and early 1991 to characterize the impact of known and/or suspected releases at the facility more completely and to provide additional information about the facility's physical environment.

The Phase I Interim Report (November 1991) presented the results of Phases IA and IB. In particular, the Phase I results indicated that constituents are present in the groundwater in the Production Area and in the soil in SWMU-11. Because the risk assessment has not yet been conducted, no imminent threat to human health or the environment has been determined. Phase II activities began after the USEPA approved the Phase II Proposal. The deliverables for Phases II and IV (the RFI Report and Corrective Measures Study Report) will be combined and submitted on September 15, 1995. The Corrective Measures Proposal (Phase III Deliverable) will not be prepared (as agreed with USEPA on November 22, 1993).

### 1.2.3 History and Phases of the Stabilization Investigation

Stabilization is an approach for controlling releases at selected RCRA facilities; it is intended to prevent or minimize further migration of contaminants while long-term corrective action remedies are evaluated. The USEPA envisions that stabilization measures will be identified and implemented under the interim measures authority with the ongoing Facility Investigation activities.

In April 1992, the possibility of taking a stabilization approach at the facility was discussed in a meeting with the USEPA; in early May, the USEPA and CIBA-GEIGY agreed to pursue a stabilization investigation in the Production Area at the facility. The stabilization investigation was integrated into the RCRA Facility Investigation through a Modification of the Order executed on 28 September 1992. The Stabilization Work Plan was submitted to the USEPA in September 1992; conditional approval of the work plan was granted on 21 December 1992.

Overall, this stabilization investigation involves three phases:

1. Investigation, including developing the Stabilization Work Plan, conducting field work, and reporting the results of the field work in the Stabilization Investigation Report;

2. Design, including developing the Design Concepts Proposal (submitted to USEPA in May 1993 along with the Stabilization Investigation Report), developing the Draft Stabilization Design Documents (submitted to USEPA in November 1993), preparing the Final Stabilization Design Documents (submitted to USEPA in June 1994), and revisions to these documents.

3. Implementation, including permitting, construction, start-up and operation of the proposed capture and treatment systems. The Stabilization Report(s) will be developed and submitted after the performance standards for stabilization have been met.

## 1.3 OBJECTIVES OF STABILIZATION

This section reviews the overall objectives of the stabilization investigation and describes the objectives and scope of the design phase of the stabilization investigation.

### 1.3.1 Objectives of the Stabilization Investigation

The three phases of the stabilization investigation are designed to meet the following two objectives:

1. Prevent or minimize contaminated groundwater in the Production Area from migrating into the Pawtuxet River.

2. Reduce concentrations of volatile organic compounds in the soil (unsaturated zone) and groundwater (saturated zone) at SWMU-11.

### 1.3.2 Objectives and Scope of the Design Phase

The design phase of the stabilization investigation has two objectives:

1. Based on the results of the aquifer and treatability tests, design an effective groundwater capture and pretreatment system for the Production Area.

2. Based on the results of the dual-phase extraction pilot program (for both the aqueous and vapor phases) at SWMU-11, design a full-scale soil vapor extraction (SVE) system for SWMU-11.

In general, the scope of the design phase includes developing detailed design drawings and technical specifications for: the groundwater capture system, the groundwater pretreatment system, and the SVE system at SWMU-11.

## 1.4 ORGANIZATION OF THIS DOCUMENT

The FSDD is presented in four volumes:

- A summary of the functional description for each system operation is presented in Chapter 2 of this document;

- Operational performance standards for the three stabilization systems are presented in Chapter 3 of this document;

- Stabilization performance standards for the three stabilization systems are presented in Chapter 4 of this document;

- Shut-down criteria/confirmatory sampling plans are presented in Chapter 5 of this document;

- The project management plan is presented in Chapter 6 of this document;

- Technical specifications (Divisions 1 through 16) are presented in Volume 2;

- A preliminary operation and maintenance (O&M) manual is presented in Volume 3; and

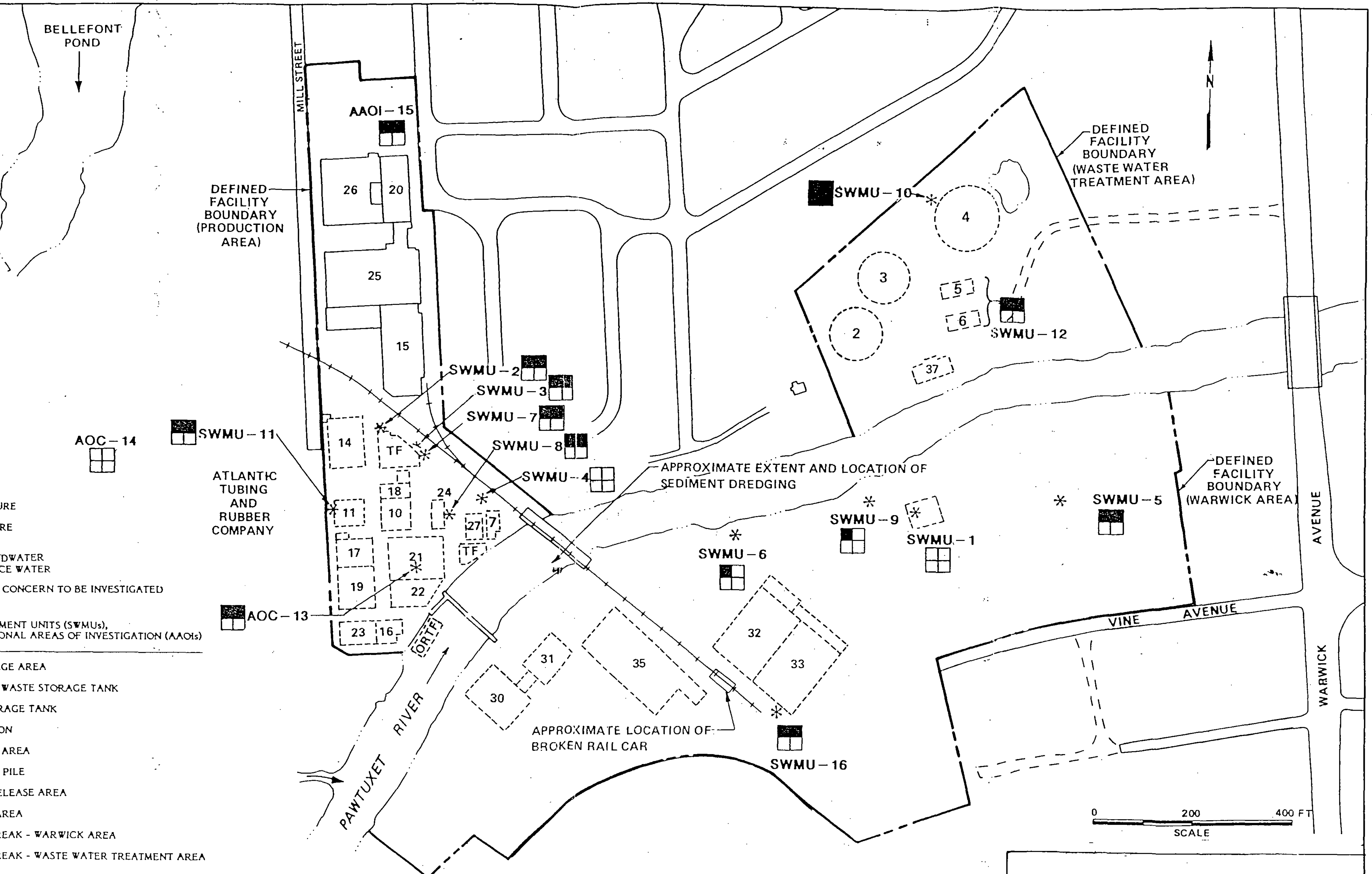
- Detailed design drawings are presented in Volume 4.

## 1.5 SUMMARY

This chapter reviewed the background about the stabilization investigation and described the contents and organization of the FSDD. Stabilization is an approach for controlling releases at selected RCRA facilities and is intended to prevent or minimize further migration of contaminants while long-term corrective action remedies can be evaluated. In early May 1992, the USEPA and CIBA-GEIGY agreed to pursue a stabilization investigation in the Production Area at the former Cranston facility. The stabilization investigation was integrated into the RCRA Facility Investigation through a Modification of the Order executed on 28 September 1992. The stabilization investigation involves 1) investigation-conducting field work, and reporting the results of the field work in the <u>Stabilization Investigation Report</u>, 2) development of the <u>Draft Stabilization Design Documents</u> and after responding to USEPA's comments, producing/revising the <u>Final Stabilization Design Documents</u>, and 3) implementation of the capture and treatment systems.

The FSDD includes four volumes. Operational performance standards, stabilization performance standards and confirmatory sampling plans are presented in Chapters 3, 4 and 5 of Volume 1, respectively. Technical specifications are presented in Volume 2. The preliminary operation and maintenance (O&M) manual is presented in Volume 3, and detailed design drawings are presented in Volume 4.

The next chapter presents the functional description for the stabilization systems.




LEGEND:

- ✳ LOCATION OF SWMU
- LOCATION OF EXISTING STRUCTURE
- LOCATION OF FORMER STRUCTURE

SOIL — GROUNDWATER
SEDIMENT — SURFACE WATER

SHADED QUADRANTS INDICATE MEDIA OF CONCERN TO BE INVESTIGATED

SOLID WASTE MANAGEMENT UNITS (SWMUs), AREAS OF CONCERN (AOCs), AND ADDITIONAL AREAS OF INVESTIGATION (AAOIs)

| | |
|---|---|
| SWMU-1 | HAZARDOUS WASTE STORAGE AREA |
| SWMU-2 | 6000-GALLON HAZARDOUS WASTE STORAGE TANK |
| SWMU-3 | 7500-GALLON, 90-DAY STORAGE TANK |
| SWMU-4 | TRASH COMPACTOR STATION |
| SWMU-5 | RIVER SEDIMENT STORAGE AREA |
| SWMU-6 | ZINC OXIDE/SOIL STORAGE PILE |
| SWMU-7 | CHLOROSULFONIC ACID RELEASE AREA |
| SWMU-8 | PRUSSIAN BLUE RELEASE AREA |
| SWMU-9 | WASTE WATER PIPELINE BREAK - WARWICK AREA |
| SWMU-10 | WASTE WATER PIPELINE BREAK - WASTE WATER TREATMENT AREA |
| SWMU-11 | TOLUENE RELEASE AREA |
| SWMU-12 | WASTE WATER TREATMENT PLANT |
| AOC-13 | PROCESS BUILDING AREA |
| AOC-14 | ATLANTIC TUBING AND RUBBER COMPANY PROPERTY |
| AAOI-15 | LABORATORY BUILDING WASTE WATER SUMP |
| SWMU-16 | MAINTENANCE DEPARTMENT CLEANING AREA |

NOTES:

1. STRUCTURE LEGEND IS INCLUDED IN THE RCRA FACILITY INVESTIGATION PROPOSAL, CHAPTER 1, FIGURE 3 – 1.
2. CIBA – GEIGY HAS IDENTIFIED ONE ADDITIONAL AREA OF INVESTIGATION (AAOI). THIS AAOI HAS BEEN DESIGNATED AS AAOI – 15.

BASE MAP SOURCE: GEOD CORPORATION OF NEWFOUNDLAND, NEW JERSEY, MAPPED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989

SWMUs, AOCs, AND AAOIs

WOODWARD – CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

| | | | | | |
|---|---|---|---|---|---|
| DR. BY: | KF | SCALE: | 1:2400 | PROJ. NO.: | 87X4660 |
| CK'D. BY: | MH | DATE: | 20 JAN 1992 | FIG. NO.: | 1-1 |

# 2.0
# FUNCTIONAL DESCRIPTION

## 2.1 OVERVIEW

This functional description describes the control philosophy of the three stabilization systems. Only an executive summary of the functional description is presented in this section. The complete functional description is presented in Volume 3 (Operation and Maintenance Manual) of the FSDD. Descriptions of the three stabilization systems are provided below. Process flow diagrams for the groundwater capture system, groundwater pretreatment system, and the soil vapor extraction (SVE) system are presented in Figures 2-1 through 2-3, respectively.

## 2.2 GROUNDWATER CAPTURE SYSTEM

The groundwater capture system is designed to minimize the migration of contaminated groundwater from the Production Area to the Pawtuxet River. This will be accomplished by lowering the water level near the bulkhead in the Production Area below the groundwater level present beneath the river so that a reversed hydraulic gradient is developed and maintained. The groundwater capture system will include up to four recovery wells to reverse the hydraulic gradient.

The design of the groundwater capture system is based on the results of the aquifer testing program (Stabilization Investigation Report and Design Concepts Proposal, May 1993). The groundwater capture system currently includes two recovery wells PW-110, PW-120 with expansion for two additional recovery wells, PW-130, and PW-140. Figure 2-4 shows the locations of the existing and proposed wells. The groundwater capture system was designed to capture constituents in groundwater, produce sufficient drawdown to reverse the hydraulic gradient along the bulkhead, and minimize the vertical migration of constituents into the deeper strata.

Recovery wells PW-110 and PW-120 were installed in July, 1993. Proposed recovery wells PW-130 and PW-140 will be installed if additional drawdown is required along the bulkhead. Each of the recovery wells will consist of a 6-inch diameter stainless steel screen, risers and a submersible pump. Well construction details for both the existing and proposed recovery wells are presented in Appendix A.

To ensure that the required hydraulic gradient reversal is maintained, water levels in selected in-river and Production Area monitoring wells/piezometers will be monitored with several local programmable logic controllers (PLCs). The static water level in the in-river monitoring wells (located on the river side of the bulkhead) will be compared to its respective Production Area well to determine the hydraulic gradient. A differential static water level of up to two-feet will be maintained along the bulkhead automatically by the PLC. Differences in water level elevations between the in-river well and its corresponding Production Area monitoring well/piezometer will result in an adjustment of the flowrate from the recovery wells by the PLC.

Water levels in the recovery wells will be monitored by the PLC to control the pumping rate and monitor drawdown. The recovery well PLCs will be linked to the main PLC control system located in the control room. The recovery well PLC, motor-starter, instrumentation, and associated piping/valves will be housed in a small pre-engineered structure around the well. The discharge from each recovery well will be conveyed to the groundwater pretreatment system via a common header and forcemain.

## 2.3 GROUNDWATER PRETREATMENT SYSTEM

The groundwater pretreatment system has been designed to remove volatile organic compounds (VOCs) from the groundwater and will consist of aqueous-phase treatment only. Metals found in the groundwater will be discharged directly to the City of Cranston POTW (via the existing sanitary sewer) without pretreatment.

Groundwater from both the groundwater capture system and soil vapor extraction (SVE) system will receive on-site pretreatment for VOCs prior to discharge to the City of Cranston POTW. To remove free-product from the SVE influent, a phase separator will be provided on the SVE influent forcemain prior to equalization. Separated free-product will flow by gravity to a free-product storage tank located in Building No. 15. Following phase-separation of the SVE influent, equalization will be provided to minimize the fluctuations in groundwater flow and contaminant loading to the pretreatment system. One equalization tank will be provided for both the groundwater capture system and SVE system groundwater.

The equalized groundwater will be pumped to the aqueous-phase activated carbon adsorption system for removal of volatile organic compounds. The equalization tank lift station will consist of two variable frequency drive (VFD) pumps and a magnetic flow meter. The VFD pumps will be "linked" (via a PLC) to the groundwater capture and SVE systems. Variations in flow from the groundwater capture system and SVE system will automatically result in an adjustment of the flowrate to the aqueous-phase activated carbon adsorption system. Prior to activated carbon adsorption, a sequestering agent may be added to maintain the soluble iron in the groundwater and prevent conversion/settling in the carbon bed. Three backwashable activated carbon units will be provided for VOC treatment. However, only two activated carbon units will be in operation at any one time. Backwashing of the carbon units will be manually initiated. Backwashing will be performed as required depending on the pressure gradient in the carbon bed. During backwashing, the carbon bed will be expanded using city water. Water from backwashing operations will be conveyed to a backwash storage tank. Once the backwashing operations are complete, water stored in the backwash storage tank will be pumped back to the equalization tank for VOC treatment prior to discharge. Sludge from the backwashing operations will be allowed to settle in the backwash tank and will be removed manually on a regular basis. When the capacity of the carbon unit has been exhausted, bulk carbon replacement will be performed.

A final pH control system will be provided to adjust the pH of the effluent before discharge to the City of Cranston sanitary sewer. Sulfuric acid ($H_2SO_4$) and sodium hydroxide (NaOH) will be used to control the pH of the groundwater within the permitted limits.

## 2.4 SOIL VAPOR EXTRACTION (SVE) SYSTEM

The SVE system is designed to remove VOCs from both the soil and groundwater in the SWMU-11 area. The SVE system consists of a soil vapor and groundwater extraction system and an vapor-phase treatment system.

### 2.4.1 Soil Vapor/Groundwater Extraction System

The SVE system includes seven extraction wells in the SWMU-11 area. These well locations are shown in Figure 2-5. Wells VE-1, VE-2, VE-3 and VE-11 are designed to extract both soil vapor and groundwater. Wells VE-7, VE-9, VE-10 are designed to extract groundwater only. Six additional observation wells will be used to monitor the influence of the dual-phase extraction and groundwater extraction system. These additional monitoring wells (VE-4, VE-5, VE-6, VE-8, MW-4S and P-4S) are shown also in Figure 2-2.

Each extraction well will be connected to the water and vapor extraction manifolds. A liquid level sensor at each well will be used to control automatically the water and vapor extraction manifold solenoid valves. A local PLC will be provided for the SVE system. The local SVE PLC will be integrated with the main PLC control system. Most of the SVE equipment will be installed in a trailer located near SWMU-11. The trailer will be partitioned into two zones for electrical classification purposes; one will be classified hazardous (Class 1, Division 1, Group D), the other will be classified non-hazardous. A sealed partition wall will be provided to separate the two zones.

Soil vapor and groundwater will be extracted independently from each of the four dual-phase extraction wells. A positive-displacement, lobe-type vacuum blower will be used to extract soil vapor from the extraction wells and transfer it to the thermal/catalytic oxidizer. The vapor extraction tank will provide a pneumatic vacuum reservoir for the vapor and function as a knockout/receiver tank for removal of water droplets, condensate and particulates that may be entrained in the incoming vapor. Liquid-level sensors in the vapor extraction tank will control automatically the discharge of any accumulated water in the tank. Dual progressive-cavity (positive-displacement) pumps will be used to extract groundwater from the extraction wells. The groundwater extraction pumps will be controlled by the vacuum pressure sensor on the water extraction tank. Extracted groundwater will be pumped to the phase-separator of the groundwater pretreatment system.

### 2.4.2 SVE Vapor-Phase Treatment System

A thermal/catalytic oxidizer panel will be installed adjacent to the SVE equipment trailer for the destruction of VOCs in the vapor-phase. Vapors from the SVE system will be conveyed to the oxidizer for treatment prior to discharge to the atmosphere. The thermal/catalytic oxidizer will be provided with an outside air purge system to prevent it from being operated until it has been suitably purged. The thermal/catalytic oxidizer will be supplied with its own control panel, which will be interlocked with the SVE control system. The oxidizer must reach an operating temperature of $140^0$ F before the SVE system will be allowed to start-up.

## 2.5 SUMMARY

A summary of the functional description for the three stabilization systems is provided in this section. The complete functional description for the stabilization action is presented in Volume 3 (Operation and Maintenance Manual).

### Groundwater Capture System

Groundwater will be pumped from up to four recovery wells in the Production Area and conveyed to the groundwater pretreatment system. Water levels in selected in-river and Production Area monitoring wells/piezometers will be monitored to determine if the gradient is reversed. A differential static water level of up to two-feet will be maintained between the in-river well and its corresponding Production Area monitoring well/piezometer by automatically adjusting the flowrate from each recovery well.

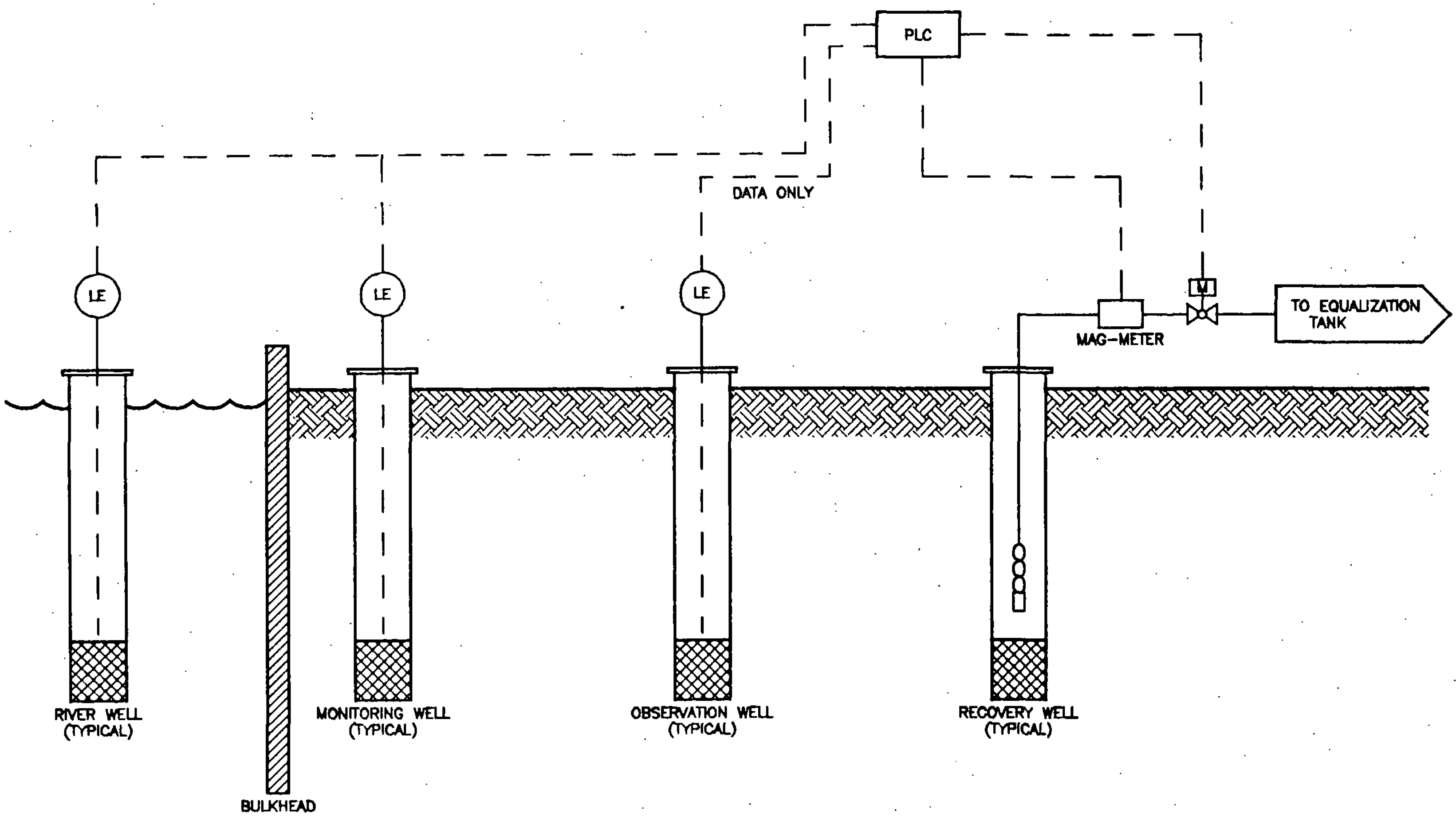
**Groundwater Pretreatment System**

Groundwater extracted from the groundwater capture and SVE system will receive on-site pretreatment prior to discharge. The groundwater pretreatment system will consist of aqueous-phase treatment and remove VOCs from the groundwater only. Phase separation will be provided on the SVE influent line to remove any free-product in the groundwater. Equalization will be provided to minimize the fluctuations in groundwater flow and contaminant loading. A metals (iron) sequestering agent may to added to prevent conversion. Aqueous-phase activated carbon will be used to remove residual organic compounds prior to discharge. A final pH control system will be provided to adjust the pH of the treated groundwater to within the permitted range of values before being discharged to the City of Cranston sanitary sewer.

**Soil Vapor Extraction (SVE) System**

The SVE system will consist of a soil vapor and groundwater extraction system and a thermal/catalytic oxidizer. The SVE system will include four dual-phase extraction wells and three groundwater extraction wells. The four dual-phase recovery wells will be operated independently to extract groundwater and soil vapor from the subsurface. A positive-displacement, lobe-type vacuum blower will be used to extract soil vapor from the extraction wells and transfer it to the thermal oxidizer for treatment prior to discharge to the atmosphere. Dual progressive-cavity (positive-displacement) pumps will be used to extract groundwater from the extraction wells. Extracted groundwater will be pumped to the groundwater pretreatment system.

The next chapter discusses the operational performance standards for the stabilization action.

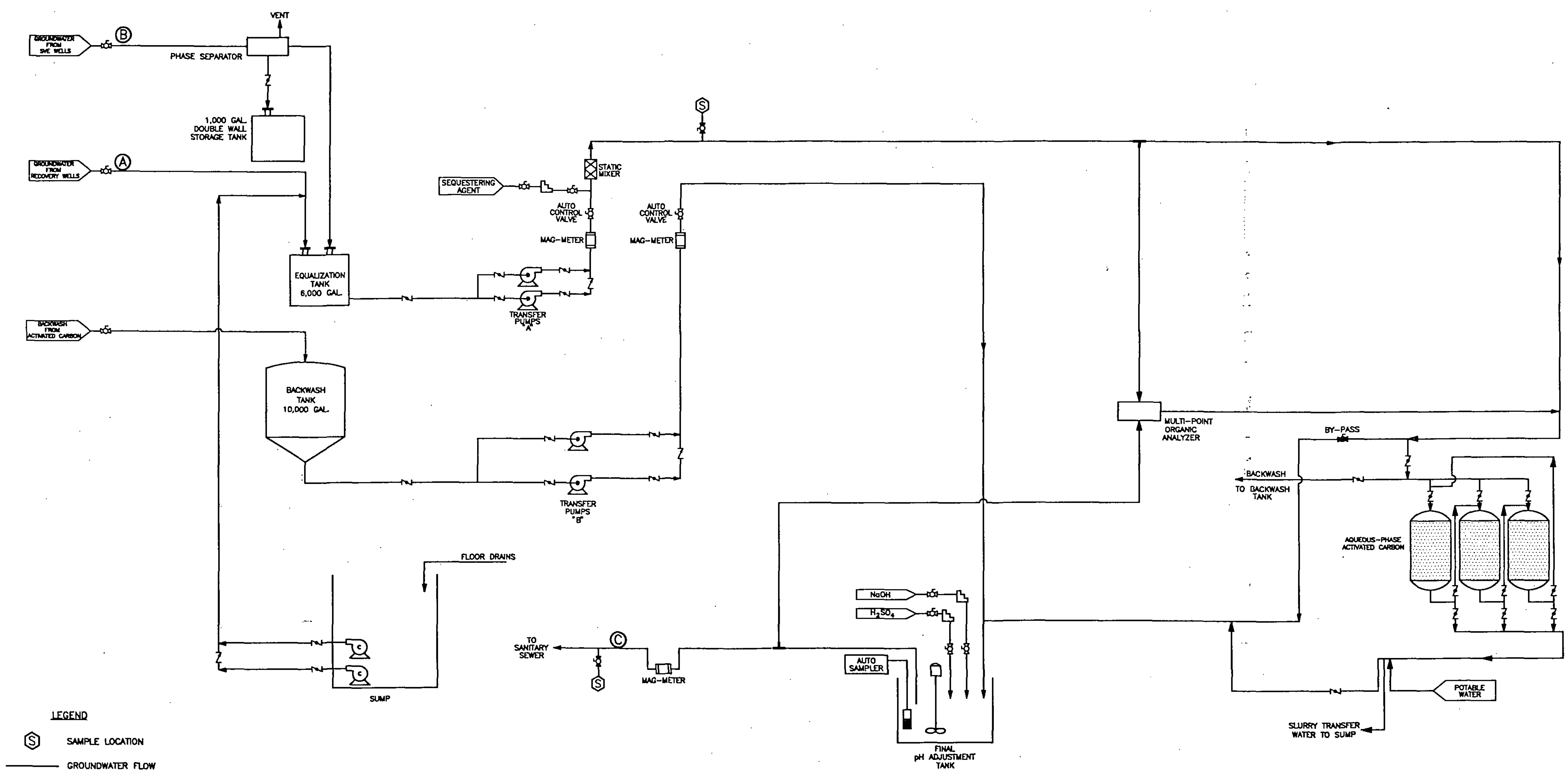



PROCESS FLOW DIAGRAM
FOR THE GROUNDWATER CAPTURE SYSTEM

**WOODWARD-CLYDE CONSULTANTS**

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DR.BY | MVB | SCALE | NONE | DWG.NO. | 74660014 | PROJ. | 67X4660D |
| CK'D.BY | JJC | DATE | JUNE 15, 1994 | FIG.NO. | 2-1 | | |




LEGEND

| | |
|---|---|
| S | SAMPLE LOCATION |
| ——— | GROUNDWATER FLOW |
| | BALL VALVE |
| | BUTTERFLY VALVE |
| | CHECK VALVE |

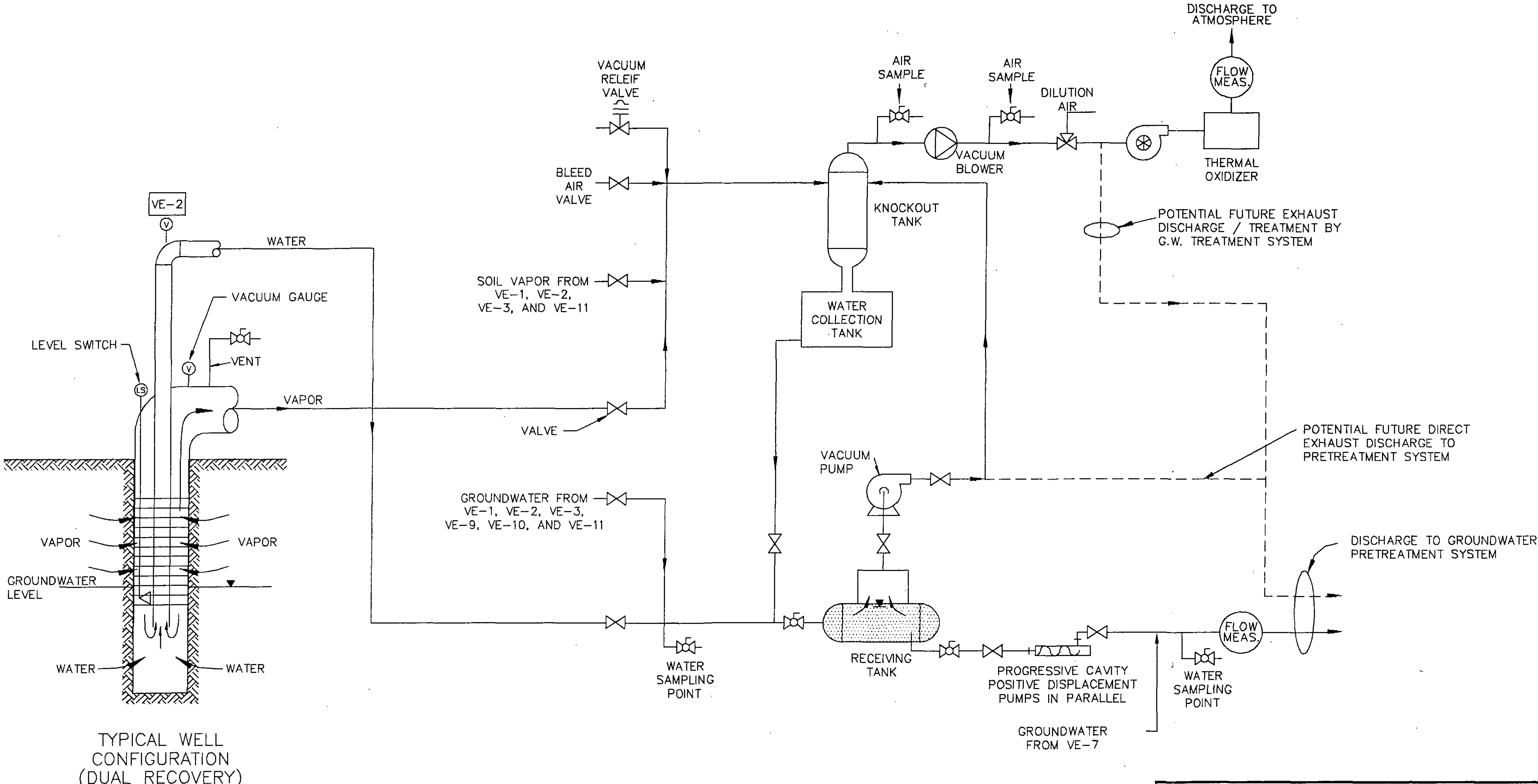
PROCESS FLOW DIAGRAM
GROUNDWATER PRETREATMENT SYSTEM
FINAL DESIGN

**WOODWARD-CLYDE CONSULTANTS**

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

| | | | |
|---|---|---|---|
| DR. BY MVB | SCALE AS SHOWN | DWG. NO. 74660019 | PROJ. NO. 87X4660 |
| CK'D. BY JJC | DATE JAN 20, 1995 | | FIG. NO. 2-2 |

File name: K:\CADD\87X4660\74660019.DWG Last edited: 95/01/20 @ 09:46



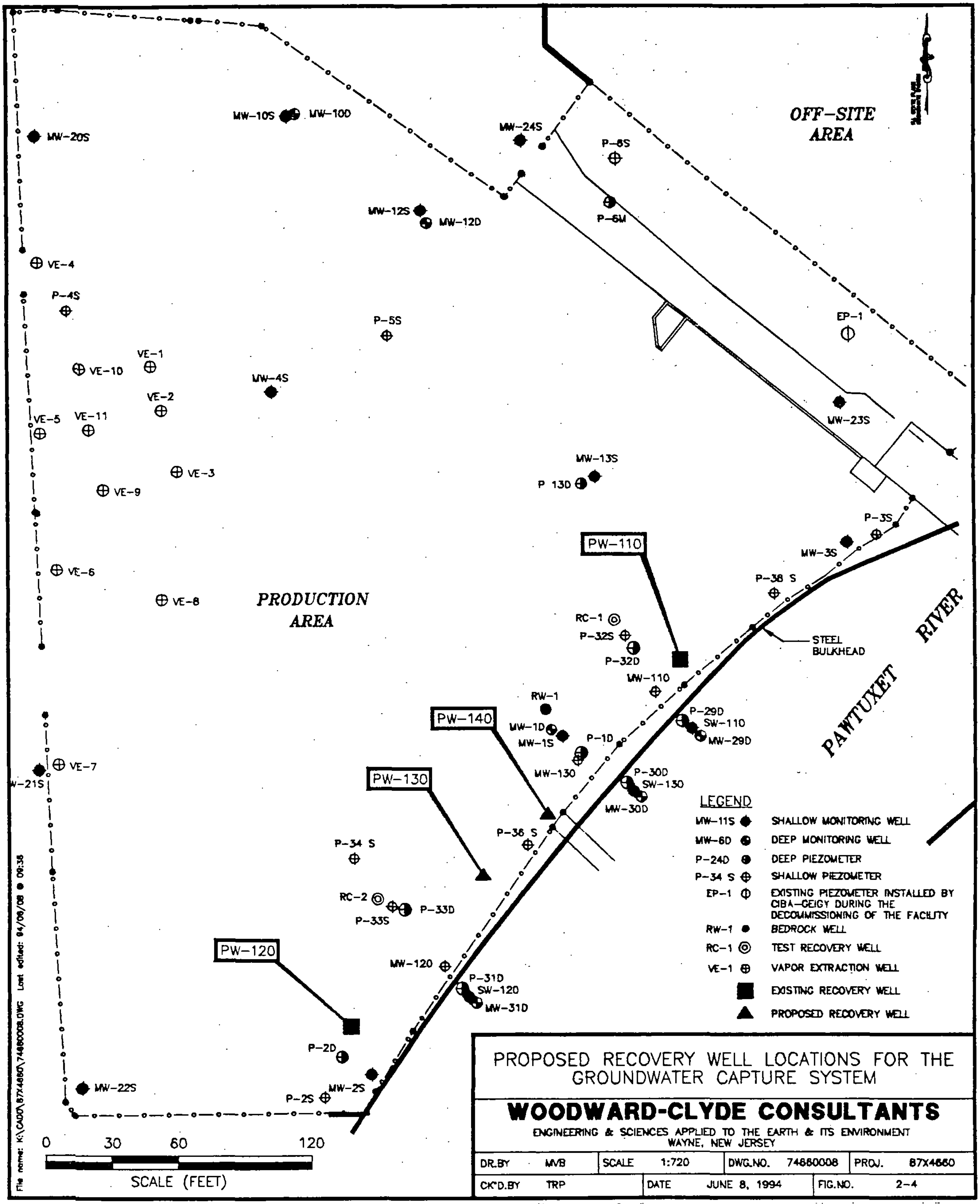

PROCESS FLOW DIAGRAM
FOR THE SOIL VAPOR
EXTRACTION SYSTEM

**WOODWARD-CLYDE CONSULTANTS**

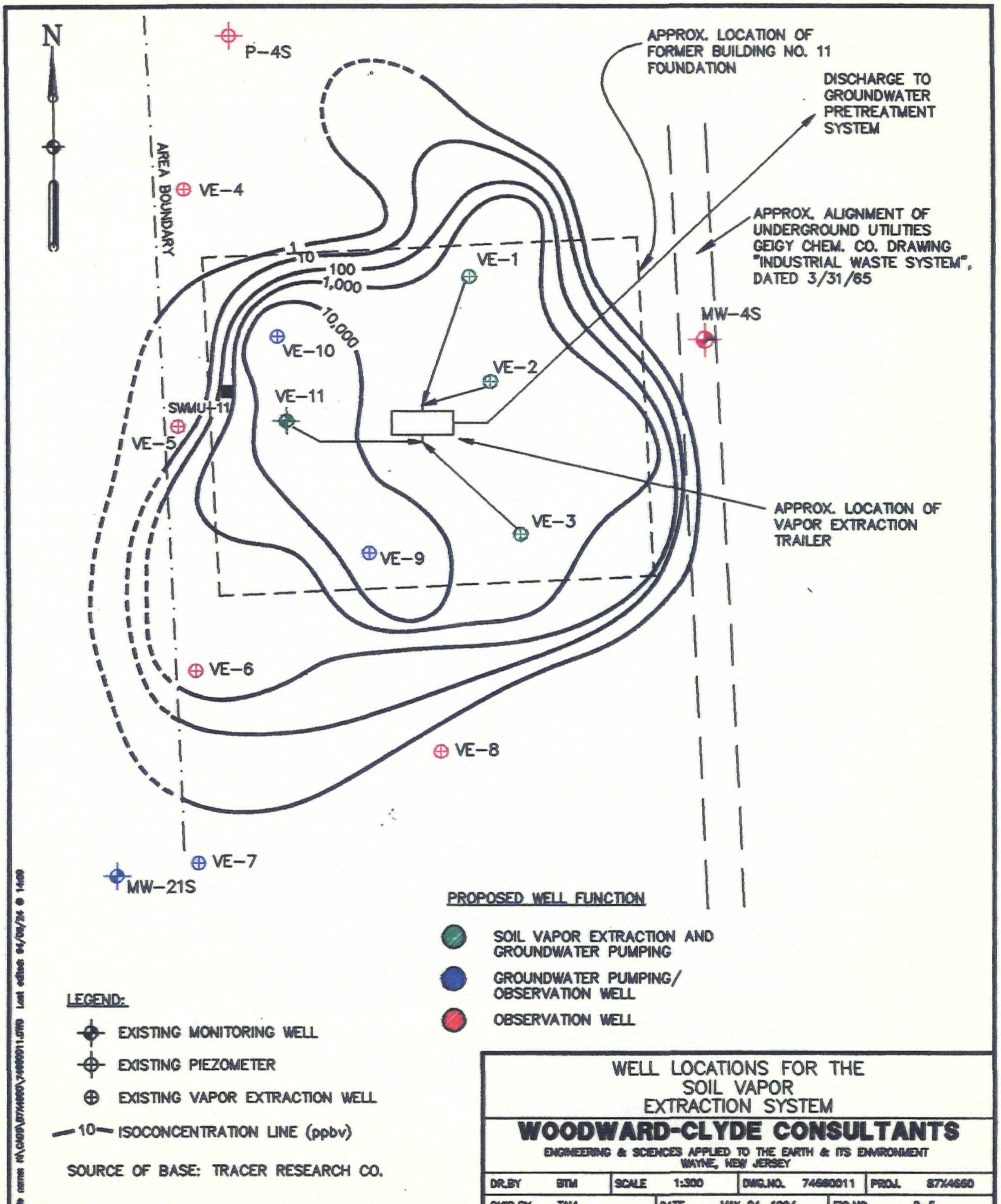
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

| DR.BY | BTM | SCALE | AS SHOWN | DWG.NO. | 74660006 | PROJ. | 87X4660 |
|---|---|---|---|---|---|---|---|
| CK'D.BY | TAM | | DATE | JUNE 15, 1994 | | FIG.NO. | 2-3 |

File name: K:\CADD\87X4660\74660006.DWG Last edited: 95/01/27 @ 16:11



OFF-SITE AREA
PRODUCTION AREA
PAWTUXET RIVER
STEEL BULKHEAD
PW-110
PW-120
PW-130
PW-140
MW-10S
MW-10D
MW-20S
MW-24S
P-6S
P-6M
MW-12S
MW-12D
VE-4
P-4S
P-5S
EP-1
VE-1
VE-10
MW-4S
VE-2
VE-5
VE-11
MW-23S
MW-13S
P 13D
VE-3
VE-9
P-3S
MW-3S
VE-6
P-38 S
VE-8
RC-1
P-32S
P-32D
MW-110
RW-1
P-29D
SW-110
MW-29D
MW-1D
MW-1S
P-1D
MW-130
P-30D
SW-130
MW-30D
W-21S
VE-7
P-36 S
P-34 S
RC-2
P-33D
P-33S
MW-120
P-31D
SW-120
MW-31D
P-2D
MW-22S
P-2S
MW-2S
LEGEND
MW-11S SHALLOW MONITORING WELL
MW-6D DEEP MONITORING WELL
P-24D DEEP PIEZOMETER
P-34 S SHALLOW PIEZOMETER
EP-1 EXISTING PIEZOMETER INSTALLED BY CIBA-GEIGY DURING THE DECOMMISSIONING OF THE FACILITY
RW-1 BEDROCK WELL
RC-1 TEST RECOVERY WELL
VE-1 VAPOR EXTRACTION WELL
EXISTING RECOVERY WELL
PROPOSED RECOVERY WELL
0 30 60 120
SCALE (FEET)
File name: K:\CAD\87X4660\74660008.DWG Last edited: 94/06/08 @ 09:38
PROPOSED RECOVERY WELL LOCATIONS FOR THE GROUNDWATER CAPTURE SYSTEM
WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY
DR.BY MVB
SCALE 1:720
DWG.NO. 74660008
PROJ. 87X4660
CK'D.BY TRP
DATE JUNE 8, 1994
FIG.NO. 2-4


N
P-4S
AREA BOUNDARY
VE-4
APPROX. LOCATION OF FORMER BUILDING NO. 11 FOUNDATION
DISCHARGE TO GROUNDWATER PRETREATMENT SYSTEM
APPROX. ALIGNMENT OF UNDERGROUND UTILITIES GEIGY CHEM. CO. DRAWING "INDUSTRIAL WASTE SYSTEM", DATED 3/31/65
1
10
100
1,000
10,000
VE-1
VE-10
VE-2
MW-4S
SWMU-11
VE-11
VE-5
APPROX. LOCATION OF VAPOR EXTRACTION TRAILER
VE-3
VE-9
VE-6
VE-8
VE-7
MW-21S
PROPOSED WELL FUNCTION
SOIL VAPOR EXTRACTION AND GROUNDWATER PUMPING
GROUNDWATER PUMPING/ OBSERVATION WELL
OBSERVATION WELL
LEGEND:
EXISTING MONITORING WELL
EXISTING PIEZOMETER
EXISTING VAPOR EXTRACTION WELL
10 ISOCONCENTRATION LINE (ppbv)
SOURCE OF BASE: TRACER RESEARCH CO.
WELL LOCATIONS FOR THE SOIL VAPOR EXTRACTION SYSTEM
WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY
DR.BY BTM
SCALE 1:300
DWG.NO. 74660011
PROJ. 87X4660
CK'D.BY TAM
DATE MAY 24, 1994
FIG.NO. 2-5

# 3.0 OPERATIONAL PERFORMANCE STANDARDS AND PERFORMANCE MONITORING

## 3.1 OVERVIEW

This chapter presents the operational performance standards for the three stabilization systems. Operational performance standards are defined as those standards that will be met (during the operation of each stabilization system) to ensure that the desired stabilization goals are achieved.

The goal of the groundwater capture system is to minimize the migration of contaminated groundwater from the Production Area to the Pawtuxet River. The operational performance standard for the groundwater capture system is to achieve sufficient drawdown in the Production Area to reverse the hydraulic gradient.

The goal of the groundwater pretreatment system is to remove constituents in the groundwater prior to discharge to the POTW. The operational performance standards of the pretreatment system are to insure that the City of Cranston discharge limitations are met.

The goal of the SVE system is to reduce the mass of VOCs from the soil at SWMU-11. The goal of the groundwater capture system at SWMU-11 is to 1) remove contaminated groundwater, and 2) lower the water table to enhance remediation by the SVE system. The operational performance standards of the SVE system are to remove VOC mass from the soil and groundwater at SWMU-11.

Operational performance standards for the three stabilization systems are discussed in three sections:

- Section 3.2 presents the operational performance standards and performance monitoring for the groundwater capture system;

- Section 3.3 presents the operational performance standards and performance monitoring for the pretreatment system; and

- Section 3.4 presents the operational performance standards and performance monitoring for the SVE system.

## 3.2 GROUNDWATER CAPTURE SYSTEM

The goal of the groundwater capture system is to prevent or minimize discharges from the Production Area to the Pawtuxet River by reversing the hydraulic gradient at the bulkhead. The operational performance standards to achieve this goal is presented here.

### 3.2.1 Operational Performance Standards

The groundwater capture system will include up to four pumping wells to reverse the hydraulic gradient at the bulkhead from its present direction towards the Pawtuxet River. Gradient reversal is achieved when water levels are lower on the landward side of the bulkhead than on the Pawtuxet River side of the bulkhead. Two wells (PW-110 and PW-120) have been installed at the locations shown in Figure 2-4. Two additional wells (PW-130 and PW-140) may be installed (at the approximate locations show in Figure 2-4), if additional drawdown is needed to reverse the hydraulic gradient in these areas. Details of the well design for the groundwater capture system are presented in Appendix A.

The performance of the groundwater capture system is based on its ability to reverse the hydraulic gradient at the bulkhead. The hydraulic gradient across the bulkhead (and its variation over time) was evaluated to establish the initial performance standards. These standards will be evaluated continuously during the operation of the groundwater capture system.

The performance standards for the groundwater capture system are based on water level elevations measured during November 1992 through August 1993; (November 30, 1992 was the date that the first round of water levels were measured after piezometers P-35S, P-36S, P-37S and P-38S were installed in the Production Area). Each well/piezometer couplet discussed in this chapter is shown on Figure 2-4 and on Drawing G-2 of Volume 4.

Differences in water level elevations and the hydraulic gradients were measured using the following well/piezometer couplets:

| Production Area Monitoring Point | In-River Monitoring Point |
|---|---|
| MW-110 (formerly P-37S) | SW-110 (formerly MW-29S) |
| MW-120 (formerly P-35S) | SW-120 (formerly MW-31S) |
| MW-130 (formerly P-1S) | SW-130 (formerly MW-30S) |
| P-2D | MW-31D |
| P-1D | MW-30D |

(Note: The following changes in well designations have been made on the drawings and specifications for ease of reference: RC-3, P-37S, and MW-29S are now designated as PW-110, MW-110, and SW-110, respectively. RC-5, P-35S, and MW-31S are now designated as PW-120, MW-120, and SW-120, and RC-4, P-1S, and MW-30S are now designated as PW-130, MW-130, and SW-130).

The differences in water level elevations and the hydraulic gradient between the Production Area monitoring points and the in-river wells is presented in Table 3-1. The hydraulic gradient was calculated by subtracting the water level elevation of the river-well from the water level elevation in the corresponding Production Area monitoring point and then dividing that number by the distance between those two points. A negative hydraulic gradient indicates a potential for groundwater flow towards the river.

As shown in Table 3-1, most of the hydraulic gradients from the nine measurement periods were determined to be negative, indicating that the groundwater flow is mostly towards the river. The average difference in water level elevations varied from -0.27 to -1.39 feet. The corresponding average hydraulic gradient varied from -0.02 to -0.06 feet/foot. The smallest difference in water level elevations and hydraulic gradient were noted between MW-120 and SW-120 near the southern end of the bulkhead. The largest difference was observed between MW-110 and SW-110 near the northern end of the bulkhead in the Production Area.

Based on the nine rounds of water level measurements and the hydraulic gradient calculations presented in Table 3-1, the following minimum drawdown goals are proposed as the initial operating performance standards for the groundwater capture system:

- 0.5 feet of drawdown in the southern portion of the bulkhead as measured by the difference in water level elevations between MW-120 and SW-120;

- 1.0 feet of drawdown in the center portion of the bulkhead as measured by the difference in water level elevations between MW-130 and SW-130; and,

- 1.7 feet of drawdown in the northern portion of the bulkhead as measured by the difference in water level elevations between MW-110 and SW-110.

A graphic presentation of the proposed initial minimum drawdown goals for this groundwater capture system is presented in Figure 3-1.

The proposed drawdown goals are based on the average water level differences across the bulkhead. To provide a safety factor, about 20 percent additional drawdown was added to the calculated drawdown. This safety factor was added to ensure that gradient reversal will be maintained. (It is customary to add a safety factor in designing groundwater recovery systems due to fluctuations in water levels). Water level elevations/drawdown will be measured both in the well couplets on each side of the bulkhead and in other monitoring points throughout the capture zone to determine the minimum drawdown needs. Details on the operational performance monitoring program are provided in Section 3.2.2.

The reversed hydraulic gradient, (based on the difference in groundwater elevations on both sides of the bulkhead), will vary with seasonal groundwater fluctuations and precipitation. Seasonal water level fluctuations occur slowly and can be compensated for in the controlled drawdown of the recovery wells that are required to maintain the reversed hydraulic gradient.

Changes in water level elevations from precipitation usually occur within 24 hours of a rainfall event. The water level data presented in the Stabilization Investigation Report and Design Concepts Proposal (May, 1993) show the impact of rainfall on water levels. In general, precipitation events greater than 1.0 inch in 24 hours resulted in water level elevation rises in each of the wells monitored continuously in the Production Area. Consistent increases in water levels were recorded in the wells and piezometers on both sides of the bulkhead after a rainfall event were noted. The relative difference in groundwater elevations on both sides of the bulkhead remained similar after a rainfall event, indicating that the gradient was unchanged. Once the reversed hydraulic gradient was established during testing, it was not changed by a rainfall event. As a result, additional pumping during/after a rainfall event to compensate for the increased water level elevations is not required.

### 3.2.2 Operational Performance Monitoring

Performance monitoring for the groundwater capture system will consist of monitoring water levels to evaluate groundwater gradient reversal and chemical monitoring to evaluate reductions in constituent concentrations in the pumped groundwater.

#### 3.2.2.1 Water Level Monitoring

The water level monitoring program includes: monitoring the difference in water levels across the bulkhead, monitoring of additional wells throughout the capture zones, and background monitoring. Specifically, the program will consist of the following:

- Monitoring the difference in water level elevations between the wells/piezometers on both sides of the bulkhead will be performed to determine whether the required gradient reversal has been achieved. Monitoring will be conducted at couplets MW-110/SW-110, MW-120/SW-120, and MW-130/SW-130 using the data logging function of the PLC. The differences measured will be used to change the pumping rates automatically to control drawdown (criteria presented later in this section). In addition, other well/piezometer couplets (P-1D/MW-30D and P-2D/MW-31D) will be monitored using capacitor probes connected to the PLC. Data from these monitoring points will be evaluated to determine the change in water levels across the bulkhead in the deeper Fine Sand unit due to pumping.

- Monitoring of wells/piezometers near the bulkhead will be performed to determine if the minimum drawdown goals are being met throughout the capture zones. This monitoring will be conducted at locations MW-2S, P-2S, P-36S, P-38S, and MW-3S using capacitor probes. Data from these monitoring points will be recorded by the PLC. These data will be evaluated twice weekly until equilibrium is met and then twice monthly after equilibrium is achieved.

- Monitoring of water levels in wells MW-10S and MW-10D will be performed to determine background groundwater conditions. These data will be collected continuously using the PLC and evaluated monthly. Changes in background water levels will be compared with changes that occur due to the pumping of the recovery wells.

The difference in water levels across the bulkhead will be monitored automatically (and on a continuous basis) by the PLC using the water level data measured from the three well couplets MW-110/SW-110, MW-120/SW-120, and MW-130/SW-130. Water level differences will be controlled by adjusting the pumping rates of the recovery wells. When more drawdown is required to maintain the reversed hydraulic gradient (due to either seasonal or other changes in water level), the pumping rates will be increased. Pumping rates will be adjusted by increasing the opening on the control valve from the pump discharge line. Adjustments of the automatic control valve will be performed automatically when the difference in the water levels between the Production Area piezometer (i.e. MW-110, MW-120, MW-130) and the corresponding in-river well (i.e. SW-110, SW-120, SW-130) indicates that a hydraulic gradient toward the river is occurring. Adjustments will be programmed to occur when the water level elevations in the Production Area wells are 0.1 feet or greater than the corresponding elevations in the river-wells for a period of at least 48 hours. Using this criteria minimizes the number of adjustments required without compromising the goals of the groundwater capture system.

#### 3.2.2.2 Chemical Monitoring

Operational performance monitoring will also include the analysis of groundwater samples. Groundwater samples will be analyzed to evaluate changes in groundwater chemistry that occur due to pumping. The following sampling program is proposed and is summarized on Table 3-2:

- Two rounds of groundwater sampling will be performed during the first year of operation in selected Production Area monitoring wells after the groundwater capture system is operational. This sampling, while part of the Phase II investigation work, will be used to evaluate constituent changes during the first year of operation. Each sample will be analyzed for Appendix IX compounds, fingerprint compounds, and major and minor ions.

- Recovery wells will be sampled quarterly to evaluate changes in groundwater chemistry and influent constituent concentrations to the pretreatment system. These samples will be analyzed for Target Compound List Volatile Organic Compounds (TCL VOCs), total iron and manganese.

- Monitoring wells MW-1S, MW-2S, MW-110, MW-120, P-36S, and P-38S will be sampled quarterly during year two and semi-annually (after year two) to evaluate chemical changes in the shallow groundwater in the Production Area. The samples will be analyzed for TCL VOCs. The frequency of groundwater sampling is being reduced after year two because the data from the eight rounds of groundwater samples collected before year 2 will be more than enough to evaluate the trends in contaminant concentrations that are occurring in groundwater due to pumping. Decreasing the sampling frequency after year two to semi-annually will not affect the evaluation of chemical data trends.

## 3.3 GROUNDWATER PRETREATMENT SYSTEM

The objective of the groundwater pretreatment system is to remove VOCs from the extracted groundwater prior to discharge to the POTW. The operational performance standard for the pretreatment system is to insure that the discharge limitations are met.

The design of the groundwater pretreatment system was based on data obtained during the bence-scale testing program and the on-site pilot pretreatment program discussed in the Stabilization Investigation Report and Design Concepts Proposal (May, 1993).

### 3.3.1 Operational Performance Standards

Groundwater from both the groundwater capture system and the SVE system will be conveyed to the pretreatment system via an above-grade forcemain. Following phase-separation, equalization, and activated carbon adsorption, the groundwater will be discharged to the City of Cranston POTW via an existing sanitary sewer connection. For the groundwater pretreatment system, the required performance standards are the negotiated City of Cranston effluent quality standards. The City of Cranston performance standards for the groundwater pretreatment system are presented in Table 3-3.

### 3.3.2 Operational Performance Monitoring

Effluent from the groundwater pretreatment system will be conveyed to the City of Cranston sanitary sewer and eventually to the POTW. Prior to entering the sanitary sewer, the effluent will be sampled using an ISCO automatic sampler. In accordance with the City of Cranston's Self-Monitoring Report requirements, 24-hour effluent composite samples will be collected twice per month (on the first and third week) for the first six months of system operation. Grab samples for VOCs will also be collected on the first and third week of every month. Analysis of the effluent will be performed to ensure that the operational performance standards noted in Section 3.3.1 are achieved. After about six months of operation, the City of Cranston may reduce the required sampling period from twice per month to bi-monthly (once every two months). Eventually, the required performance sampling/reporting effort may be reduced to quarterly by the City of Cranston.

## 3.4 SOIL VAPOR EXTRACTION (SVE) SYSTEM

The goal of the SVE system in SWMU-11 is to reduce the mass of VOCs from the soil and groundwater. The groundwater portion of the SWMU-11 system is designed to remove contaminated groundwater (where SVE is taking place) and lower the water table so that additional soil can be remediated. The operational performance standards of the SVE system are presented here.

### 3.4.1 Operational Performance Standards

The design of the stabilization system for SWMU-11 includes both soil vapor and groundwater extraction to remove constituents from the saturated and unsaturated zones. The operational performance of the SVE and groundwater extraction systems in SWMU-11 are based on their ability to reduce contaminant mass in the soil and groundwater.

The operational performance of the SVE system will be determined by the concentrations of constituents being removed from the soil. In order to remove constituents from the soil gas, a vacuum must be applied with an air flow measured throughout the SWMU-11 area.

Soil vapor will be extracted from VE-1, VE-2, VE-3, and VE-11. Extraction wells VE-7, VE-9, and VE-10, initially will be used for groundwater capture only. Vacuum and airflow will be monitored in each of these seven wells and in the observation wells (VE-4, VE-5, VE-6, VE-8, P-4S, and MW-4S). Based on the results of the HIVAC pilot test (presented in the Stabilization Investigation Report and Design Concepts Proposal (May 1993)), the amount of vacuum that will be maintained throughout the footprint of former Building No. 11 will range from about 1.0 to 5.2 millimeters of Hg; airflow rates are expected to range from about 0.8 to 2.0 liters per minute (per well). The final vacuum/airflow operational performance standards will be selected after start-up.

Soil vapors extracted at SWMU-11 will be treated by a thermal/catalytic oxidizer prior to discharge to the atmosphere. The operational performance standards proposed for the treatment of soil vapors from the SVE system will be the standards developed and established by RIDEM's - Division of Air and Hazardous Materials (Table 3-4). The RIDEM performance standards for the soil vapor are identical to those performance standards presented for the vapor-phase portion of the groundwater pretreatment system (presented in Section 3.3.3).

The performance of the groundwater extraction system for SWMU-11 will be based on the mass of constituents removed from the area and from the benefit achieved by lowering the water table to expose more soil for constituent removal by the SVE system. There are no hydraulic performance criteria proposed for the SWMU-11 groundwater extraction system. However, drawdown will be measured periodically in the seven extraction and six observation wells (Figure 2-5) to evaluate the influence of groundwater extraction on the SVE system.

The groundwater extracted by the SWMU-11 wells will be conveyed to the groundwater pretreatment system for treatment prior to discharge to the City of Cranston POTW (via the existing sanitary sewer). Performance standards for the groundwater treatment system are presented in Table 3-3.

### 3.4.2 Operational Performance Monitoring

Operational performance monitoring for the SVE system will be performed to ensure that air emissions are in compliance with RIDEM's standards and the groundwater discharges are in compliance with the POTW limits (as stated in Sections 3.3.2 and 3.3.4). Operational performance monitoring of the air emissions and groundwater discharges will be included as part of the groundwater pretreatment system operation performance monitoring which is presented in Sections 3.3.2 and 3.3.4.

Operational monitoring will consist of monthly sampling of soil vapor (one sample per month) from the vacuum blower effluent. These samples will be analyzed for VOCs. Groundwater from each of the seven SVE system wells will be sampled quarterly; samples will be analyzed for VOCs.

## 3.5 SUMMARY

This chapter described the operational performance standards and the operational performance monitoring for the groundwater capture, groundwater pretreatment, and SVE systems.

## Groundwater Capture System

The groundwater capture system will include up to four pumping wells to reverse the hydraulic gradient at the bulkhead. Representative hydraulic gradients were determined from well/piezometer couplets that are located on both sides of the bulkhead. The minimum drawdown goals for the groundwater capture system are 0.5 feet of drawdown in the southern portion of the bulkhead; 1.0 feet of drawdown in the center portion of the bulkhead; and 1.7 feet of drawdown in the northern portion of the bulkhead. The proposed drawdown goals are based on the average water level difference across the bulkhead and include a 20 percent safety factor.

Operational performance monitoring for the groundwater recovery system will consist of monitoring water levels and the analyzing groundwater samples. Monitoring will be performed to determine the difference in water level elevations between monitoring points on both sides of the bulkhead to determine whether the gradient is reversed, if the recovery wells produce the drawdown required to reverse the gradient throughout their capture zones, and to observe background water levels.

Groundwater samples will be analyzed to evaluate changes in groundwater chemistry that occur due to pumping. Two rounds of groundwater sampling will be conducted as part of the Phase II RCRA Facility Investigation. In addition, groundwater from the recovery wells will be sampled quarterly and selected monitoring wells will be sampled semi-annually (see Table 3-1). These samples will be analyzed for VOCs.

## Groundwater Pretreatment System

The groundwater pretreatment system is designed to remove VOCs from the groundwater extracted from the Production Area. Groundwater from both the groundwater capture system and the SVE system will be conveyed to the groundwater pretreatment system. Following pretreatment, the groundwater will be discharged to the City of Cranston POTW via an existing sanitary sewer. For the groundwater pretreatment system, the negotiated City of Cranston POTW discharge standards will be met.

In accordance with the City of Cranston's Self-Monitoring Report requirements, 24-hour effluent composite samples will be collected twice per month for the first six months of system operation. Grab samples for VOCs will also be collected on the first and third week of every month. After about six months of operation, the City of Cranston may reduce the required sampling period from twice per month to bi-monthly.

<u>**Soil Vapor Extraction (SVE) System**</u>

The design of the stabilization system for SWMU-11 includes both soil vapor and groundwater extraction to remove constituents from the saturated and unsaturated zones. The operational performance of the SVE system will be based on its ability to reduce constituent concentrations. This performance will be measured by the vacuum and airflow in the proposed observation wells. The performance of the SWMU-11 groundwater extraction system will be based on the mass of constituents removed. Soil vapors extracted during stabilization activities in SWMU-11 will be treated using a thermal/catalytic oxidizer prior to discharge to the atmosphere. The performance standards proposed for the soil vapor portion of the SVE system will be the maximum allowable emission standards developed by RIDEM's - Division of Air and Hazardous Materials. Groundwater extracted by the SVE system will be conveyed to the groundwater pretreatment system for treatment prior to discharge to the City of Cranston POTW.

The next chapter discusses the performance standards for the stabilization system.

# TABLE 3-1
# DIFFERENCES IN WATER LEVEL ELEVATIONS AND HYDRAULIC GRADIENTS ACROSS THE BULKHEAD

| Monitoring Point | Reference Elevation (ft MSL) | DEPTH TO WATER MEASUREMENTS (feet below reference elevation) 11/30/92 | 2/3/93 | 2/25/93 | 3/31/93 | 4/29/93 | 5/27/93 | 6/30/93 | 7/29/93 | 8/30/93 |
|---|---|---|---|---|---|---|---|---|---|---|
| P-35S | 15.32 | 5.97 | 5.93 | 5.51 | 3.46 | 5.02 | 6.86 | 7.24 | 6.99 | 7.35 |
| P-2D | 16.00 | 6.77 | 6.59 | 6.14 | 3.80 | 5.65 | 7.24 | 7.66 | 7.49 | 7.10 |
| MW-31S | 16.27 | 6.97 | 6.79 | 6.46 | 4.34 | 6.42 | 8.04 | 9.70 | 8.18 | 8.45 |
| MW-31D | 16.21 | 6.97 | 6.96 | 6.52 | 4.30 | 6.43 | 8.24 | 8.38 | 7.99 | 8.30 |
| | | | | | | | | | | |
| P-1S | 16.41 | 6.55 | 7.25 | 6.78 | 4.70 | 7.95 | 7.50 | 7.96 | 7.41 | 8.18 |
| P-1D | 16.33 | 7.20 | 8.15 | 7.81 | 7.30 | 6.92 | 7.20 | 7.64 | 7.91 | 8.00 |
| MW-30S | 16.70 | 8.31 | 8.37 | 7.87 | 5.20 | 7.73 | 9.40 | 8.40 | 9.40 | 9.68 |
| MW-30D | 16.67 | 8.27 | 8.20 | 7.93 | 5.22 | 7.76 | 9.50 | 9.70 | 9.42 | 9.66 |
| | | | | | | | | | | |
| P-37S | 15.69 | 5.73 | 6.23 | 5.81 | 3.41 | 5.21 | 6.50 | 6.90 | 6.70 | 7.00 |
| MW-29S | 16.66 | 8.15 | 8.21 | 7.97 | 5.21 | 7.80 | 8.50 | 9.78 | 9.36 | 9.71 |

| Monitoring Point | Reference Elevation (ft MSL) | WATER LEVEL ELEVATIONS (feet Mean Sea Level) 11/30/92 | 2/3/93 | 2/25/93 | 3/31/93 | 4/29/93 | 5/27/93 | 6/30/93 | 7/29/93 | 8/30/93 |
|---|---|---|---|---|---|---|---|---|---|---|
| P-35S | 15.32 | 9.35 | 9.39 | 9.81 | 11.86 | 10.30 | 8.46 | 8.08 | 8.33 | 7.97 |
| P-2D | 16.00 | 9.23 | 9.41 | 9.86 | 12.20 | 10.35 | 8.76 | 8.34 | 8.51 | 8.90 |
| MW-31S | 16.27 | 9.30 | 9.48 | 9.81 | 11.93 | 9.85 | 8.23 | 6.57 | 8.09 | 7.82 |
| MW-31D | 16.21 | 9.24 | 9.25 | 9.69 | 11.91 | 9.78 | 7.97 | 7.83 | 8.22 | 7.91 |
| | | | | | | | | | | |
| P-1S | 16.41 | 9.86 | 9.16 | 9.63 | 11.71 | 8.46 | 8.91 | 8.45 | 9.00 | 8.23 |
| P-1D | 16.33 | 9.13 | 8.18 | 8.52 | 9.03 | 9.41 | 9.13 | 8.69 | 8.42 | 8.33 |
| MW-30S | 16.70 | 8.39 | 8.33 | 8.83 | 11.50 | 8.97 | 7.30 | 8.30 | 7.30 | 7.02 |
| MW-30D | 16.67 | 8.40 | 8.47 | 8.74 | 11.45 | 8.91 | 7.17 | 6.97 | 7.25 | 7.01 |
| | | | | | | | | | | |
| P-37S | 15.69 | 9.96 | 9.46 | 9.88 | 12.28 | 10.48 | 9.19 | 8.79 | 8.99 | 8.69 |
| MW-29S | 16.66 | 8.51 | 8.45 | 8.69 | 11.45 | 8.86 | 8.16 | 6.88 | 7.30 | 6.95 |

| Monitoring Point | Distance Between Points (ft) | DIFFERENCE IN WATER LEVEL ELEVATIONS ACROSS THE BULKHEAD (feet) 11/30/93 | 2/3/93 | 2/25/93 | 3/31/93 | 4/29/93 | 5/27/93 | 6/30/93 | 7/29/93 | 8/30/93 | Average Difference (ft) | Average Gradient (feet/foot) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P-35S/MW-31S | 17 | -0.05 | 0.09 | 0.00 | 0.07 | -0.45 | -0.23 | -1.51 | -0.24 | -0.15 | -0.27 | -0.02 |
| P-2D/MW-31D | 65 | 0.01 | -0.16 | -0.17 | -0.29 | -0.57 | -0.79 | -0.51 | -0.29 | -0.99 | -0.42 | -0.01 |
| | | | | | | | | | | | | |
| P-1S/MW-30S | 30 | -1.47 | -0.83 | -0.80 | -0.21 | 0.51 | -1.61 | -0.15 | -1.70 | -1.21 | -0.83 | -0.03 |
| P-1D/MW-30D | 33 | -0.73 | 0.29 | 0.22 | 2.42 | -0.50 | -1.96 | -1.72 | -1.17 | -1.32 | -0.50 | -0.02 |
| | | | | | | | | | | | | |
| P-37S/MW-29S | 23 | -1.45 | -1.01 | -1.19 | -0.83 | -1.62 | -1.03 | -1.91 | -1.69 | -1.74 | -1.39 | -0.06 |
| | | negative numbers indicate flow potential into river | | | | | | | | | | |

## TABLE 3-2
## GROUNDWATER CAPTURE SYSTEM
## OPERATIONAL PERFORMANCE
## CHEMICAL MONITORING PROGRAM

| Wells to Be Sampled | Year 1 After Startup | Year 2 After Startup | After Year 2 |
|---|---|---|---|
| Selected Production Area Monitoring Wells | Sampled semi-annually (as part of Phase II) for Appendix IX, fingerprint compounds, major and minor ions | No sampling proposed (Phase II RFI completed) | No sampling proposed (Phase II RFI completed) |
| Recovery Wells PW-110, PW-120, PW-130*, PW-140* | Sampled quarterly for TCL VOCs and total iron and manganese | Sampled quarterly for TCL VOCs and total iron and manganese | Sampled quarterly for TCL VOCs and total iron and manganese |
| Monitoring Wells MW-1S, MW-2S, MW-110, MW-120, P-36S, P-38S | Sampled semi-annually (as part of Phase II) for Appendix IX, fingerprint compounds, major and minor ions | Sampled quarterly for TCL VOCs | Sampled semi-annually for TCL VOCs |

* Recovery wells PW-130 and PW-140 will be installed only if needed

TCL VOCs - Target Compound List Volatile Organic Compounds

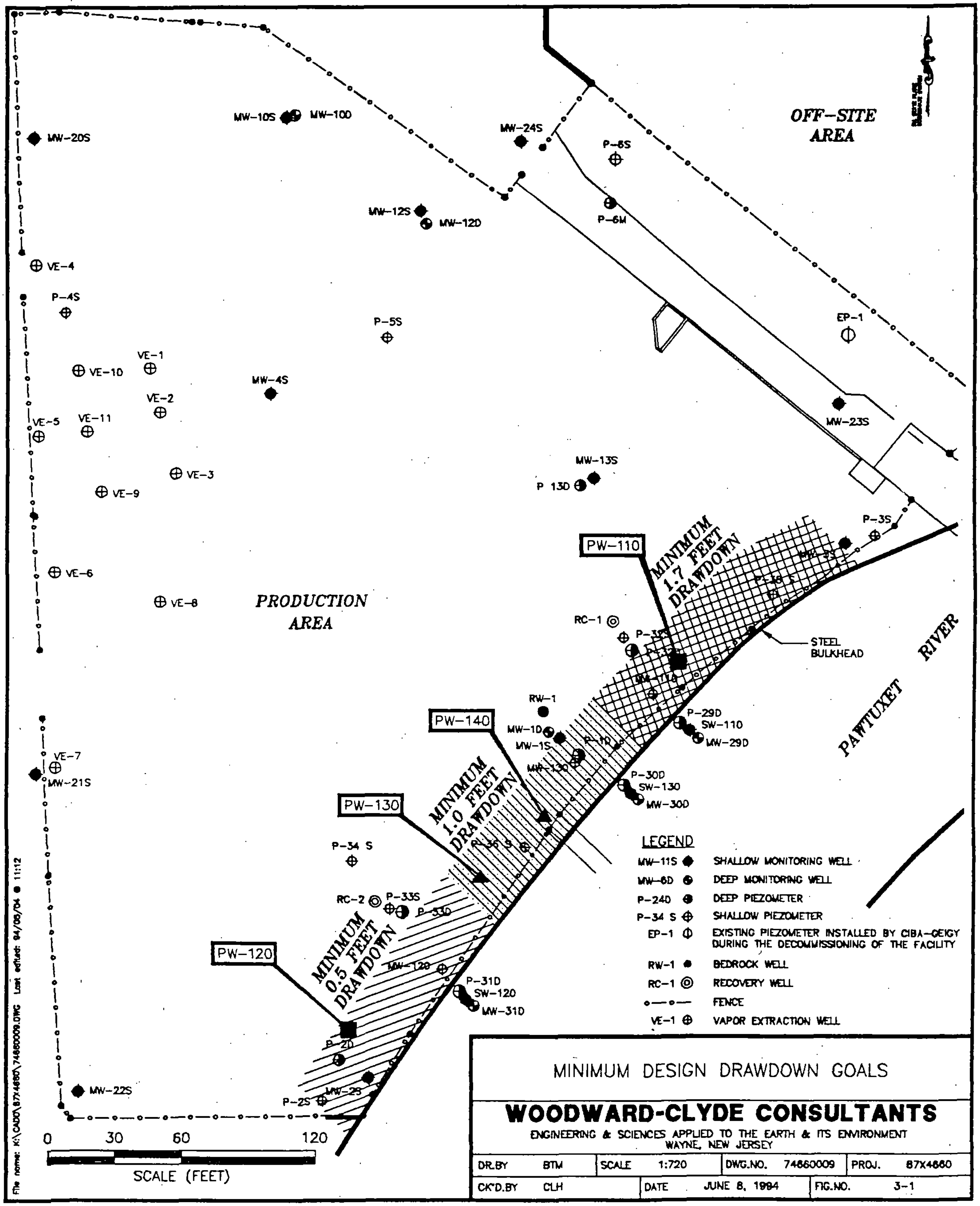
**Table 3-3**
**Proposed Performance Standards**
**Stabilization Action - Cranston, Rhode Island**
**Groundwater Pretreatment System**
**Aqueous-Phase Treatment**

| **Parameter** | **Effluent Concentration (mg/l)** |
|---|---|
| Antimony (total) | 0.05 |
| Arsenic (total) | 0.1 |
| Beryllium (total) | 0.005 |
| Boron (total) | 1.0 |
| Cadmium (total) | 0.04 |
| Chromium (total) | 0.4 |
| Copper (total) | 1.0 |
| Cyanide (total) | 0.3 |
| Iron (total) | XX.0 * |
| Lead (total) | 0.3 |
| Manganese (total) | 2.0 |
| Mercury (total) | 0.005 |
| Nickel (total) | 0.7 |
| Phenols (total) | 1.0 |
| Selenium (total) | 0.01 |
| Silver (total) | 0.1 |
| Thallium (total) | 0.005 |
| Zinc (total) | 1.0 |
| Total Toxic Organics | 2.13 |
| Oil and Grease | 25 Mineral/Petroleum Origin<br>100 Animal/Vegetable Origin |
| pH | 5.5 to 9.5 units |

* - To be negotiated with the City of Cranston POTW.

| Table 3-4<br>Proposed Performance Standards<br>Stabilization Action - Cranston, Rhode Island<br>Soil Vapor Extraction System<br>Vapor-Phase Treatment | |
|---|---|
| **Parameter** | **Maximum Emission Rate (lb/hr)** |
| Acrylonitrile | 0.004 |
| Aniline | 0.04 |
| O-Anisidine | 0.001 |
| Antimony & Antimony Compounds | 1.14 |
| Arsenic & Arsenic Compounds | 0.0 |
| Benzene | 0.005 |
| Benzidine | 0.0 |
| Benzotrichloride | 0.0 |
| Benzyl Chloride | 0.005 |
| Cadmium & Cadmium Compounds | 0.0 |
| Carbon Tetrachloride | 0.001 |
| Chloroform | 0.002 |
| Chromium & Chromium Compounds | 0.0 |
| 3,3'-dichlorobenzidine | 0.0001 |
| Dioctyl Phthalate | 0.03 |
| Diphenyl | 0.02 |
| Diphenyl Amine | 1.14 |
| Epichlorohydrin | 0.04 |
| Ethylene Dichloride | 0.002 |
| Ethylene Oxide | 0.0005 |
| Hydrazine | 0.0 |
| Hydrogen Chloride | 1.14 |
| Hydrogen Fluoride | 0.1 |

| Table 3-4<br>Proposed Performance Standards<br>Stabilization Action - Cranston, Rhode Island<br>Soil Vapor Extraction System<br>Vapor-Phase Treatment | |
|---|---|
| **Parameter** | **Maximum Emission Rate (lb/hr)** |
| Lead | 1.14 |
| Manganese & Manganese Compounds | 0.01 |
| Methyl Cellosolve | 1.14 |
| Methylene Biphenyl Iscyante (MDI) | 0.003 |
| 4,4'-Methylene bis(2-chloroaniliine) | 0.05 |
| Methylene Chloride | 0.01 |
| Nickel & Nickel Compounds | 0.0001 |
| 5-Nitro (o-anisidine) | 0.004 |
| 2-Nitropropane | 0.01 |
| Perchloroethylene | 0.002 |
| Styrene | 1.14 |
| Toluene | 1.14 |
| Toluene-2,4 Diisocyanate (TDI) | 0.001 |
| O-Toluidene | 0.002 |
| 1,1,2 Trichloroethane | 0.3 |
| Trichloroethylene | 0.02 |
| Triethylamine | 1.14 |
| Xylene | 1.14 |
| Other Contaminants | 10 |


OFF-SITE AREA
PRODUCTION AREA
PAWTUXET RIVER
STEEL BULKHEAD
MW-10S
MW-10D
MW-20S
MW-24S
P-6S
P-6M
MW-12S
MW-12D
VE-4
P-4S
P-5S
EP-1
VE-1
VE-10
VE-2
MW-4S
VE-5
VE-11
MW-23S
MW-13S
P 13D
VE-3
VE-9
P-3S
VE-6
VE-8
PW-110
MINIMUM 1.7 FEET DRAWDOWN
RC-1
RW-1
PW-140
P-29D
SW-110
MW-29D
MW-1D
MW-1S
VE-7
MW-21S
PW-130
MINIMUM 1.0 FEET DRAWDOWN
P-30D
SW-130
MW-30D
P-34 S
RC-2
P-33S
P-33D
PW-120
MINIMUM 0.5 FEET DRAWDOWN
P-31D
SW-120
MW-31D
P-2D
MW-22S
MW-2S
P-2S
LEGEND
MW-11S SHALLOW MONITORING WELL
MW-6D DEEP MONITORING WELL
P-24D DEEP PIEZOMETER
P-34 S SHALLOW PIEZOMETER
EP-1 EXISTING PIEZOMETER INSTALLED BY CIBA-GEIGY DURING THE DECOMMISSIONING OF THE FACILITY
RW-1 BEDROCK WELL
RC-1 RECOVERY WELL
FENCE
VE-1 VAPOR EXTRACTION WELL
0 30 60 120
SCALE (FEET)
MINIMUM DESIGN DRAWDOWN GOALS
WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY
DR.BY BTM
SCALE 1:720
DWG.NO. 74860009
PROJ. 87X4860
CK'D.BY CLH
DATE JUNE 8, 1994
FIG.NO. 3-1

# 4.0
# STABILIZATION PERFORMANCE STANDARDS

## 4.1 OVERVIEW

This section presents the performance standards for the three systems that will be operated under this stabilization program. Stabilization performance standards are the criteria that USEPA will use to measure and evaluate if stabilization has achieved its intended beneficial effect. The stabilization performance standards are summarized here and are presented in detail in Section 4.2) The methodology that will be used to determine if the stabilization performance standards have been achieved are presented in Section 4.3. The stabilization performance standards for the three systems are:

- *Groundwater Capture System* - To minimize the migration of contaminated groundwater from the Production Area into the Pawtuxet River.

- *Groundwater Pretreatment System* - To treat and discharge extracted groundwater in accordance with federal, state, and local requirements.

- *Soil Vapor Extraction System* - To significantly reduce VOC concentrations in the soil gas at SWMU-11.

## 4.2 STABILIZATION OBJECTIVES AND PERFORMANCE STANDARDS

### 4.2.1 Summary of Stabilization Objectives

Stabilization (under RCRA Corrective Action) is an interim measure to stabilize or control the releases of hazardous constituents while long-term corrective action remedies are evaluated and implemented. Stabilization is being implemented for the Cranston site mainly to minimize the migration of groundwater into the Pawtuxet River.

The two objectives of stabilization for this facility are to 1) prevent or minimize contaminated groundwater in the Production Area from migrating into the Pawtuxet River and its sediments and 2) reduce the concentrations of VOCs in the soil and groundwater at SWMU-11.

### 4.2.2 Stabilization Performance Standards

Stabilization performance standards are the criteria that USEPA will use to measure if stabilization has achieved its intended beneficial effect. Achieving the stabilization performance standards will be determined by the following: how well the groundwater capture system reduces constituent discharges into the Pawtuxet River; the ability of the groundwater pretreatment system to meet discharge requirements, and to what extent constituent concentrations are reduced in SWMU-11. Each stabilization measure will be operated until it achieves its specific stabilization performance standard. The specific performance standards for the three stabilization measures are discussed here.

#### 4.2.2.1 Groundwater Capture System

The stabilization performance standard for the groundwater capture system is to minimize the migration of contaminated groundwater from the Production Area into the Pawtuxet River (and its sediments). This stabilization performance standard will be achieved by pumping the recovery wells at rates that reverse the hydraulic gradient at the bulkhead in the Production Area. Maintaining the reversed gradient will be evaluated using the data collected during operational performance monitoring (e.g.,water levels in selected wells and flow rates from the recovery wells).

Shut-down of the groundwater capture system (Chapter 5.0) is not anticipated during stabilization. Media protection standards (MPS) will be an integral part of determining when this program can be terminated. Selection of these numerical standards must wait for the results of the PHERE and the MPS proposal which are to be submitted to USEPA as part of the RFI deliverables in September of 1995.

#### 4.2.2.2 Groundwater Pretreatment System

The stabilization performance standard for the groundwater pretreatment system is to treat and discharge extracted groundwater in accordance with federal, state, and local requirements. Operational performance monitoring (discussed in Chapter 3.0) will be conducted to ensure that the pretreatment system removes the constituents to below the appropriate operational performance standards (i.e., the City of Cranston POTW discharge requirements).

Shut-down of the pretreatment system is partially linked to the operation of the groundwater capture system. The pretreatment facility will be shut-down after the groundwater capture system is shut-down. If the raw groundwater from the capture system is consistently cleaner than POTW discharge requirements, the pretreatment plant may be shut-down before the groundwater capture system is shut-down.

#### 4.2.2.3 Soil Vapor Extraction (SVE) System

The stabilization performance standard for the SVE system is to significantly reduce the levels of VOCs in the soil gas at SWMU-11. A significant reduction is defined as the decrease in the VOC concentrations (most notably toluene) in the soil gas from its initial (or start-up) concentration until the concentrations remain statistically flat for a six month period based on monthly sampling data. A second stabilization performance standard for the SVE system is to remove groundwater in the SWMU-11 area so that more soil could be exposed and influenced by the SVE system. There are no quantitative stabilization standards for the SVE system.

Achievement of this stabilization performance standard will be evaluated during the operation of the SVE system. Operational monitoring data (vacuum, airflow, water levels in selected wells, soil gas effluent VOC concentrations) will be monitored and evaluated. Shut-down of the SVE system will be implemented when a significant reduction in the concentrations of VOCs in the soil gas at SWMU-11 are observed.

Achievement of these objectives will be evaluated throughout stabilization. The next section discusses the criteria that will be used to evaluate the achievement of the stabilization performance standards.

## 4.3 EVALUATION OF STABILIZATION PERFORMANCE STANDARDS

This section presents a summary of the criteria that will be used to determine when the stabilization performance standards for each of the three stabilization measures have been achieved. Achievement of the stabilization performance standards will be monitored in three ways:

- First, operational monitoring data (collected during the operation of each stabilization system) will be evaluated to ensure that the operational performance standards (presented in Chapter 3.0) are being met;

- Second, chemical monitoring data will be evaluated to determine when the shut-down criteria (presented in Chapter 5.0) have been achieved; and,

- Third, confirmatory sampling (and evaluation of data) will be performed after shut-down to ensure that the stabilization measure was successful.

Operational performance standards (Chapter 3.0) are the standards that will be met during the operation of each stabilization measure to ensure that the stabilization performance standards are achieved. Shut-down is linked to the achievement of the stabilization performance standards. Confirmatory sampling will be conducted to ensure that the stabilization performance standards have been met.

### 4.3.1 Groundwater Capture System

The groundwater capture system, which will include up to four recovery wells and 17 monitoring wells/piezometers, will be operated to maintain a reversed hydraulic gradient at the bulkhead of the Production Area. Maintaining the reversed hydraulic gradient will ensure that the groundwater capture system is minimizing the discharge of contaminated groundwater into the Pawtuxet River (achieving its stabilization performance standard).

To develop and maintain a reversed hydraulic gradient, sufficient groundwater in the Production Area will be extracted to ensure that the water levels measured in a Production Area wells are lower than the water levels in the Pawtuxet River wells (directly across the bulkhead). The stabilization performance standards that have been developed are the minimum drawdown goals that will be maintained throughout the implementation of this stabilization measure. The drawdown goals are shown on Figure 3-1, presented in detail in Section 3.2.1, and are summarized here as follows.

- 0.5 feet of drawdown in the southern portion of the bulkhead;

- 1.0 feet of drawdown in the central portion of the bulkhead; and,

- 1.7 feet of drawdown in the northern portion of the bulkhead.

These drawdown goals are based on the average water level difference across the bulkhead. A safety factor of 20 percent was added to the calculated drawdown to assure that gradient reversal is complete across the entire area of the bulkhead where capture is required.

Operational performance monitoring data (water levels in the recovery wells and the monitoring wells/piezometers) will be evaluated to ensure that the reversed hydraulic gradient (the stabilization performance standard) is maintained. Water levels will be monitored throughout the operation of the groundwater capture system.

Chemical monitoring (analysis of groundwater samples) will be conducted throughout the operation of this stabilization measure to evaluate changes in groundwater chemistry that occur as a result of pumping. The analytical data will be used to evaluate reductions in groundwater constituent concentrations, determine if flushing and surging may be beneficial in reducing constituent concentrations, and determine if the shut-down criteria (which will be evaluated during the CMS) have been achieved. Chemical monitoring will include sampling groundwater from the recovery wells and selected monitoring wells as discussed in Section 3.2.2.2.

The groundwater capture system will operate throughout stabilization. The groundwater capture system implemented during stabilization will be re-evaluated during the CMS. It is expected that the groundwater capture system (implemented during stabilization) will be the final corrective measure for remediating contaminated groundwater at this site. The groundwater capture system will be shut down only after the MPS for groundwater have been met. These standards will be developed during Phase II of the RCRA Facility Investigation and will be submitted to USEPA in 1995.

Periodic shut-downs of the groundwater capture system are expected for maintenance and/or for flushing/surging (if it is determined feasible as a technique to reduce the concentrations of constituents in the groundwater). Such limited shut-downs will not result in releases of constituents to the Pawtuxet River.

Confirmatory sampling of the groundwater will be conducted to determine if the shut-down criteria have been met. Since shut-down is part of the final remedy, confirmatory sampling of groundwater will not be conducted during stabilization. Gradient reversal will be confirmed through the evaluation of operational monitoring data (as previously discussed); it is not considered part of the confirmatory sampling program.

### 4.3.2 Groundwater Pretreatment System

The stabilization performance standards that have been developed for the groundwater pretreatment are the City of Cranston POTW discharge limits. These discharge limits are presented in Table 3-3, of Section 3.3.1.

Operational performance monitoring data will be evaluated throughout the stabilization implementation period to ensure that the required VOC removal of the groundwater is maintained.

Chemical monitoring of the influent groundwater will be conducted throughout the operation of this stabilization measure to evaluate any changes in groundwater chemistry as a result of pumping. Chemical monitoring for the groundwater pretreatment system is discussed in Section 3.3.2.

The groundwater pretreatment system will operate throughout stabilization. The groundwater pretreatment system implemented during stabilization will also be re-evaluated during development of the CMS. However, it is expected that the groundwater pretreatment system implemented during stabilization will be the final corrective measure for remediating captured contaminated groundwater at this site.

Periodic shut-downs of the groundwater pretreatment system are expected for maintenance, equipment replacement and selected process operations (carbon replacement). Such shut-downs of the groundwater pretreatment system should not result in the release of constituents to the Pawtuxet River.

### 4.3.3 Soil Vapor Extraction (SVE) System

The SVE system, which includes seven vapor/groundwater extraction wells and six monitoring wells, will be operated to achieve the stabilization performance standard of reducing VOC concentrations in the soil gas at SWMU-11. The SVE system will be operated until the stabilization performance standard has been achieved. During operation of the SVE system, the following operational monitoring data will be collected: vacuum, airflow, water levels in the groundwater extraction wells, soil gas constituent concentrations from the blower effluent, and VOC concentrations in the seven groundwater extraction wells. The following operational performance monitoring data will be evaluated to ensure that the stabilization performance standards are being met:

- Vacuum and airflow will be monitored throughout the operation of the SVE system to determine the effectiveness of the blower (the area of influence of the SVE system). The preliminary operational performance standards for vacuum and airflow are 1.0 to 5.2 mm of mercury and 0.8 to 2.0 liters per minute, respectively;

- Water levels will be monitored in the seven groundwater extraction wells to determine how much of the soil is being exposed to the SVE system as a result of lowering the water table. The lowest sustainable water level in each of the extraction wells will be the operational performance standard;

- Blower effluent will be sampled monthly to determine the concentrations of constituents in the soil gas. These soil gas samples will be analyzed by a laboratory for VOCs. The data from these samples will be used to track the reduction in VOC concentrations (and to determine when the stabilization performance standard is being achieved);

- Groundwater from the seven extraction wells will be sampled quarterly to evaluate changes in VOC concentrations in the groundwater at SWMU-11 from the SVE system groundwater extraction system. There are no operational or stabilization performance standards for these groundwater data.

The shut-down of the SVE system will occur when it has achieved its stabilization performance standard (or environmental benefit) of significantly reducing the concentration of constituents in the soil gas (the effluent gas that is recovered from the blower) in SWMU-11. A significant reduction is the decrease in concentrations of VOCs (most notably toluene) in the soil gas from its initial (or start-up) concentration until the concentrations remain statistically flat for a six month period (based on monthly sampling data).

There will be no separate decision made on the shut-down of the groundwater extraction wells in SWMU-11. The groundwater extraction wells will be shut-down when the SVE system is shut-down. This shut-down will not based on the analytical results obtained from the groundwater samples. However, the groundwater VOC results will be used to determine if the environmental benefit (i.e., the reduction in VOC levels in the SWMU-11 groundwater) was achieved with this stabilization measure.

Prestart-up soil gas and soil sampling will be conducted to obtain baseline levels of VOCs in the soil gas and soil in SWMU-11. Confirmatory soil gas and soil sampling will be conducted when it is determined that the stabilization performance standard for SWMU-11 has been met. Comparison of the baseline results to the confirmatory sample results will be used to determine the level of environmental benefit that is achieved (reduction in constituent concentrations).

Baseline and confirmatory sampling will be conducted by advancing borings and sampling soil from the same general locations and depths before the SVE system is started and after the system is shut-down. Borings will be advanced and split-spoon samples collected continuously from 2-feet below grade to the water table. The headspace of each soil sample will be screened in the field to determine the relative concentrations of VOCs prior to and after cleanup by the SVE system. The soil sample with the highest headspace reading from each boring will be selected for laboratory analysis.

There are no specific shut-down criteria for groundwater in SWMU-11. Since the purpose of the groundwater extraction in SWMU-11 is to expose more of the soil to the action of the SVE system, the shut-down of the groundwater extraction in SWMU-11 will be tested with the shut-down of the SVE system. If (for other reasons) it is determined that it would be beneficial to re-start groundwater extraction in SWMU-11, this will be discussed with USEPA. Such a decision will be evaluated in light of the fact that the groundwater from SWMU-11 is within the capture zone of the groundwater capture system wells.

## 4.4 SUMMARY

The stabilization performance standards (the reversal of the groundwater gradient by the groundwater capture system, the treatment of constituents in the groundwater and air streams to the appropriate discharge levels by the pretreatment system, and a significant reduction in the concentration of VOCs in the soil gas in SWMU-11 by the soil vapor extraction system) will be achieved through implementation of the stabilization measures as designed. Specific operational performance standards (proposed in FSDD) will be measured during operational performance monitoring to assure that the stabilization performance standards are being met. The shut down of a stabilization measure will be evaluated during operations based on the whether it has achieved its stabilization performance standard.

The groundwater capture system will achieve its stabilization performance standard of gradient reversal and maintain that standard throughout stabilization (with the exception of short periodic shut-downs for maintenance, etc.). There is no stabilization performance standard established for the shut-down of the groundwater capture system. The stabilization groundwater capture system will be operated throughout stabilization and evaluated during the CMS for its use as part of the final remedy for the Production Area groundwater. Therefore, the shut-down of the groundwater capture system will be determined as part of the final remedy.

The groundwater treatment system will achieve its stabilization performance standard by treating extracted groundwater to acceptable discharge limits. Shut-down of the pretreatment system is partially linked to the operation of the groundwater capture system. The pretreatment facility will be shut-down after the groundwater capture system is shut-down. If the effluent from the site is consistently cleaner than POTW discharge requirements, the pretreatment plant may be shut-down before the groundwater capture system is shut-down.

The SVE system will achieve its stabilization performance standard by removing VOCs in the soil and soil gas in SWMU-11. The shut-down of the SVE system will occur when it has achieved the stabilization performance goal of significantly reducing the level of constituents in the soil gas recovered from SWMU-11. A significant reduction is the decrease in concentrations of VOCs (most notably toluene) in the soil gas from its initial (or start-up) concentrations to the concentrations which remain statistically flat for a six month period (based on monthly sampling data). To determine how much of an environmental benefit has been achieved in SWMU-11, prestart-up (baseline) and confirmatory soil gas and soil sampling will be conducted.

5.0
# SHUT-DOWN CRITERIA
# CONFIRMATORY SAMPLING PLANS

## 5.1 OVERVIEW

This chapter presents the shut-down criteria and confirmatory sampling plans for the groundwater capture system, groundwater pretreatment system, and the SVE system. Operational monitoring data will be evaluated as an indicator that the shut-down criteria have been met. Confirmatory sampling will be conducted after the system is shut-down to ensure that constituent concentrations in the targeted environmental media have met the shut-down criteria.

Shut-down criteria and confirmatory sampling plans for the three stabilization systems are discussed in three sections:

- Section 5.2 presents the shut-down criteria and confirmatory sampling plan for the groundwater capture system;
- Section 5.3 presents the shut-down criteria and confirmatory sampling plan for the groundwater pretreatment system; and
- Section 5.4 presents the shut-down criteria and confirmatory sampling plan for the SVE system.

## 5.2 GROUNDWATER CAPTURE SYSTEM

The groundwater capture system is designed to reverse the hydraulic gradient at the bulkhead. The shut-down criteria and confirmatory sampling plan for the groundwater capture system are presented here. Confirmatory sampling will be performed after the groundwater capture system is shut-down to ensure that the shut-down criteria have been met.

### 5.2.1 Shut-Down Criteria

Groundwater capture will take place in the Production Area until the shut-down criteria are met. These shut-down criteria have not been developed because these criteria will be based on media protection standards (MPS). These standards will be developed during Phase II of the RCRA Facility Investigation.

In the interim, the groundwater capture system will be monitored (as described in Section 3.2.2.2). If the concentration of VOCs in the groundwater become statistically flat for four sampling rounds, then the possibility of flushing/surging the aquifer will be considered.

Intermittent shut down of the groundwater capture system may result in an increase in constituent concentrations in groundwater because the constituents that are adsorbed to the soil (above the drawdown water level) may become dissolved in groundwater following recovery. The operational monitoring data will be used to determine if flushing/surging will reduce constituent concentrations in groundwater. By evaluating concentration trends of selected constituents over time, the trend of constituent levels, both during pumping and after pumping is stopped, will be established. These data can be used to establish the optimum pumping schedule for the groundwater capture system (pumping for the minimum amount of time and achieving the maximum benefit).

If flushing/surging is considered to be feasible, it will most likely be performed as part of the final measure for remediating contaminated groundwater in the Production Area. The shut-down criteria for this activity will be determined as part of the design for the final remedy.

### 5.2.2 Confirmatory Sampling Plan

Confirmatory sampling for the groundwater capture system will be conducted to determine if the shut-down criteria have been met. Groundwater in recovery wells (PW-110, PW-120) and in monitoring wells/piezometers (MW-1S, MW-2S, MW-110, MW-120, P-36S, and P-38S) will be sampled once every 2 months for the first 6 months after the groundwater capture system is shut down. Thereafter, these wells will be sampled semi-annually for an additional year. Groundwater sampled during confirmatory sampling will be analyzed for TCL VOCs only, the primary constituents of concern detected in the Production Area groundwater. (Note, a different confirmatory sampling schedule will be followed if flushing/surging is conducted. This schedule will be developed after operations have commenced.)

Increases in constituent concentrations in groundwater may be observed after the capture system is shut down. If increases in VOC constituent concentrations are detected in a confirmatory sample, that well (or wells) will be re-sampled. If the increased constituent concentrations are confirmed and exceed the specified shut-down criteria, then the benefits of re-starting the groundwater capture system (and pretreatment system) will be evaluated.. Details for re-starting the groundwater capture system will be developed as part of the design of the final remedy for the site.

## 5.3 GROUNDWATER PRETREATMENT SYSTEM

The objective of the groundwater pretreatment system is to remove VOCs from the extracted groundwater during stabilization. The shut-down criteria for the pretreatment system is presented here.

### 5.3.1 Shut-Down Criteria

The groundwater pretreatment system will be operated as long as groundwater from either the groundwater capture system or the SVE system is being extracted. If the extracted groundwater from the groundwater capture system and SVE system is determined to be consistently below the discharge requirements established by the City of Cranston POTW, the groundwater pretreatment will be shut-down and extracted groundwater will be discharged directly to the City of Cranston POTW.

As with any treatment system, temporary shut-down periods for equipment replacement, maintenance and emergency repairs are anticipated during operation of the system. Shut-down periods for regular equipment maintenance or instrumentation re-calibration could run from 1 to 2 weeks, possibly longer, depending on the type of maintenance or re-calibration required. Major equipment failure or replacement could require a system shut-down of 6 to 10 weeks, depending on the availability, type and installation procedures for the equipment. Catastrophic system failures could require shut-down periods in excess of 10 weeks. Based on the calculations presented in the Stabilization Investigation Report and Design Concepts Proposal (May 1993), the travel time of groundwater beyond the capture zone was determined to be at least 4 to 6 months. As a result, shut-down periods such as those noted above should not impact meeting the objectives of stabilization.

### 5.3.2 Confirmatory Sampling Plan

There is no confirmatory sampling required for the groundwater pretreatment system. Any requirements for decommissioning (and decontamination) will be performed in accordance with the regulations appropriate when the system is no longer operational.

## 5.4 SOIL VAPOR EXTRACTION (SVE) SYSTEM

The design of the stabilization system for SWMU-11 includes extraction of both soil vapor and groundwater to remove VOCs from the saturated and unsaturated zones. The shut-down criteria and confirmatory sampling plan for the SVE system are presented here. Sampling will be performed after the SVE system is shut-down to determine the benefits achieved from operating the SVE system.

### 5.4.1 Shut-Down Criteria

The shut-down criteria for the SVE system will be based on the operational performance monitoring data presented in Section 3.4.2. The SVE system will be operated until the concentrations of VOCs in the extracted soil vapor remain statistically flat (asymptotic as determined by data regression) for a six month period using monthly soil vapor data. Increases in soil gas VOC concentrations may be observed after the SVE system is shut down. The goal of the SVE system is to remove constituent mass from the unsaturated soil, not to achieve a specific cleanup level. If soil gas concentrations increase after shut-down, the benefits of continuing the operation of this system will be evaluated. Prior to re-starting the SVE system (if appropriate), the results of this evaluation will be discussed with USEPA.

The shut down of the groundwater recovery wells in SWMU-11 will be linked to the operation of the SVE system. When the SVE system is shut down, pumping of groundwater (from wells VE-1, VE-2, VE-3, VE-7, VE-9, VE-10, VE-11) in SWMU-11 will be terminated. This decision is based on the goals of the groundwater extraction system in SWMU-11. Groundwater is being pumped at SWMU-11 to reduce VOC constituent mass and to aid in the efficiency of the SVE system by lowering water levels and exposing more soil for SVE cleanup.

There are no quantitative shut-down criteria for groundwater in SWMU-11. If the concentrations of VOCs in the groundwater at SWMU-11 are significantly higher than the constituent levels measured in the recovery wells along the bulkhead, then re-starting the groundwater extraction pumps at SWMU-11 will be considered. Prior to re-starting these pumps, the results of this evaluation will be discussed with USEPA.

### 5.4.2 Confirmatory Sampling Plan

Because there are no quantitative shut-down criteria for the SVE system, confirmatory sampling of soil vapor and groundwater (at SWMU-11) will not be performed. After shut-down is achieved at SWMU-11, significant VOC mass will have been removed from both the soil and groundwater. Re-starting the SVE system (vapor extraction and/or groundwater recovery wells) will be considered, if it is cost-effective as compared to other remedial alternatives. Re-starting the SVE system will be discussed with USEPA, after these results have been evaluated.

Soil sampling will be performed at SWMU-11 to evaluate the effectiveness of the SVE system after the shut-down criteria for the SVE system has been met. The scope of this Phase II Release Characterization sampling task is detailed in Chapter 2 of the Stabilization Work Plan (1992). Soil will be sampled at selected SWMU-11 locations. Borings will be advanced and split-spoon samples will be collected from 2 feet below grade to the water table. The headspace of all soil samples will be screened in the field for VOCs. The results of this analysis will be used to select samples for laboratory analysis of target analytes.

## 5.5 SUMMARY

This chapter described the shut-down criteria and confirmatory sampling plans for the groundwater capture, groundwater pretreatment and SVE systems.

### Groundwater Capture System

The final cleanup criteria for the groundwater capture system will be based on the MPS which will be developed during Phase II of the RCRA Facility Investigation. Confirmatory sampling of the groundwater capture system will be performed after the shut-down criteria for the groundwater capture system have been satisfied. Recovery wells and six monitoring wells will be sampled once every 2 months for the first 6 months after the groundwater capture system is shut down. Thereafter, these wells will be sampled semi-annually for an additional year.

### Groundwater Pretreatment System

There is no shut-down criteria or confirmatory sampling plan for the groundwater pretreatment system. The groundwater pretreatment system will be operated as long as groundwater from the groundwater capture system and SVE system is being pumped. Shut-down periods for regular equipment maintenance or re-calibration, major equipment failure/replacement, or catastrophic system failures are possible. Routine shut-down periods of less than 4 to 6 months will not impact achieving the overall goals of the stabilization investigation.

### Soil Vapor Extraction (SVE) System

The SVE system will be operated until either the concentrations of VOCs in the extracted soil vapor remain statistically flat for a six month period based on monthly soil vapor analytical data or until the VOC concentrations in groundwater remain statistically flat for a period of four sampling rounds.

Confirmatory sampling for the SVE system will not be performed after the shut-down criteria have been satisfied. There are no quantitative shut-down criteria for the SVE system.

Restarting of the SVE system (vapor extraction and/or groundwater recovery wells) will be considered if it is cost-effective as compared to other remedial alternatives. Soil at SWMU-11 will be sampled after the shut-down criteria are achieved. This sampling activity (Phase II Release Characterization) will evaluate the effectiveness of the SVE system.

The next chapter discusses the project management plan for stabilization.

# 6.0
# PROJECT MANAGEMENT

## 6.1 OVERVIEW

Project management ensures that all work necessary for the stabilization investigation will be completed in a timely fashion. A project management plan for the RCRA Facility Investigation was presented in Volume 1 of the RCRA Facility Investigation Proposal. That plan described the organization of the project and identified the tasks to be accomplished (including deliverable reports) as well as the schedule for completing those tasks. The project management plan was updated in Chapter 18 of the Phase I Interim Report and Phase II Proposal (submitted in November 1991), in Chapter 7 of the Phase II Pawtuxet River Proposal (submitted in January 1992), in Chapter 6 of the Stabilization Work Plan (submitted in August 1992), in the Stabilization Investigation Report and Design Concepts Proposal (submitted in May 1993) and in the Draft Stabilization Design Documents (submitted in November 1993).

This chapter also updates (not replaces) the project management plan; it addresses project management issues only for the activities associated with the stabilization investigation, including:

- the project organization for the stabilization investigation (Section 6.2);
- the schedule for the stabilization investigation (Section 6.3); and
- contingency plans and other considerations for the stabilization investigation (Section 6.4).

Section 6.5 summarizes this chapter.

## 6.2 PROJECT ORGANIZATION

The project organization for this stabilization investigation ultimately reports to the USEPA and centers on the CIBA-GEIGY Project Coordinator who is responsible for: coordinating the interaction among all project participants, and ensuring that the objectives of the stabilization investigation are met. The organization structure for the stabilization investigation is presented in Figure 6-1. This organizational chart was revised (from Figure 6-1 of the Stabilization Investigation Report and Design Concepts Proposal) (May, 1993) to incorporate changes needed for the implementation phase of the investigation.

## 6.3 SCHEDULE

The stabilization investigation is on a separate schedule from the RCRA Facility Investigation being conducted at the site. This schedule is shown in Figure 6-2. This section discusses the two remaining components of the stabilization investigation: implementation and reporting.

### 6.3.1 Implementation Phase

The implementation phase of the stabilization program was begun on October 29 1994, with the advertizement by CIBA-GEIGY of select equipment. In general, the implementation phase of the stabilization action will include the following items:

- development of remaining construction bid packages;
- advertisement of remaining contract documents;
- evaluation of the bids/award of contract(s);
- procurement of equipment;
- construction;
- start-up and testing;
- long-term operation and maintenance;
- monitoring; and

- preparation of future stabilization reports after the performance standards are met.

### 6.3.2 Stabilization Reports

During the implementation phase, information will continue to be delivered formally to the USEPA in the form of Monthly Progress Reports and major reports at key points during the stabilization investigation. This section discusses briefly the deliverables for each of these reporting mechanisms.

- Monthly Progress Reports - Activities performed as part of the stabilization investigation will continue to be discussed in the Monthly Progress Reports. These reports will be submitted on or before the 10th day of each month.

- Stabilization Reports - Delivered to the USEPA three months after the approved performance standards have been met in the Production Area.

## 6.4 CONTINGENCIES AND CONSIDERATIONS

The schedule for stabilization is very tight, so successful management and timely completion of this project depends on two risk management procedures - identifying:

- the *contingencies* that may arise and outlining plans to counter them; and

- *critical success factors* - those management issues that will "make or break" the successful and timely completion of the stabilization investigation.

### 6.4.1 Contingencies and Planned Responses

Three contingencies have been identified at this point for the stabilization investigation:

- Permit to discharge pretreated groundwater to the City of Cranston POTW may be delayed;

- other permits or approvals required for stabilization activities may be refused or delayed; and

- equipment procurement, delivery, and/or construction may be delayed.

These contingencies, and the plans for managing each, are discussed in this section. In addition, the assumptions for designing the stabilization measures also should be regarded as contingencies.

<u>Groundwater Discharge Permit for the Pretreatment System Delayed</u>

Discharge of pretreated groundwater from the pretreatment system to the City of Cranston POTW will require obtaining a industrial wastewater discharge permit. Should the discharge permit be delayed, CIBA-GEIGY will initiate weekly tracking of the permit approval process with the City of Cranston to ensure the required groundwater discharge permit is obtained as soon as possible. If unforeseen (or significant) delays are encountered in obtaining this permit from the City of Cranston, then the schedule for subsequent activities in the stabilization investigation will be impacted.

<u>Other Permits/Approvals Refused or Delayed</u>

A variety of other permits (e.g., construction permits) and approvals will need to be obtained for the implementation phase of the stabilization investigation. Because the nature and number of such permits/approvals, the time required to obtain permits/approvals may not be reflected accurately in the schedule. Every attempt will be made to minimize the routine delays encountered during permitting. However, any significant delays encountered in obtaining other permits/approvals will impact the schedule for the stabilization investigation.

## Equipment Procurement, Delivery, and/or Construction Delayed

Equipment for the groundwater capture, pretreatment system and the SVE system will be ordered from several manufacturers/distributors and delivered to the site; the systems will then be constructed on-site. It is likely that some of the equipment will require a long-lead time to procure. To minimize potential impacts to the schedule, CIBA-GEIGY may pre-purchase the long-lead items prior to award of the construction contract. Alternate equipment and/or suppliers will also be identified prior to construction. However, any significant delays encountered in equipment procurement, delivery, and/or construction will impact the schedule for the stabilization investigation.

## Assumptions for Designing the Stabilization Measures

The following general assumptions were made during the design phase; these assumptions are also regarded as contingencies:

- POTW acceptance of groundwater discharge - It is assumed that the necessary permits/approvals will be obtained, and that the necessary procedures will be established, so that the POTW will accept pretreated groundwater. As discussed earlier, delays or refusals in obtaining permits and/or approvals will impact the schedule.

- Wells pumped will depend on field conditions - Field conditions may change before or during implementation of stabilization, so it is assumed that, if no response is observed at a well proposed for pumping, one or more new wells may need to be installed and tested.

- Trace constituents in the groundwater will not be problematic - During the stabilization pilot testing program, some constituents were detected occasionally and in trace concentrations; it is assumed that those constituents will not be encountered at concentrations that affect the ability of the pretreatment system to meet the required discharge limitations.

### 6.4.2 Critical Success Factors

Two critical success factors have been identified during the stabilization investigation including:

- vendor-supplied equipment must be delivered on schedule; and
- contractor-performed construction must be completed on schedule.

This section discusses these critical success factors.

**Vendor-Supplied Equipment Delivery**

Reliable equipment vendors must be identified for providing the equipment required and specified for the groundwater capture, the pretreatment and the SVE systems. Contractual penalties in the form of liquidated damages may be used to help ensure that vendors deliver the required equipment on schedule. However, if vendors supplying critical components fail to meet negotiated deadlines, the schedule for later stabilization phases could be impacted significantly.

**Contractor-Performed Construction**

Several reliable general contractors (and sub-contractors) must be identified for constructing the groundwater capture, the pretreatment and the SVE systems. However, if the contractors constructing the critical components of the systems fail to meet negotiated deadlines, the schedule for later stabilization phases could be impacted significantly.

## 6.5 SUMMARY

This chapter addressed project management issues for the stabilization investigation currently in progress at the former CIBA-GEIGY facility in Cranston, Rhode Island. The project direction for this investigation falls under the USEPA-Region I and the

CIBA-GEIGY Project Coordinator. The current stabilization investigation and the Phase II activities for the RCRA Facility Investigation are on separate schedules. The schedule for the stabilization implementation phase is organized around the following group of activities:

1. Identifying reliable general contractors, developing a list of potential pre-qualified contractors, and evaluating and selecting contractors and subcontractors.

Three specific contingencies have been identified for the stabilization investigation:

1. permits to discharge pretreated groundwater from the groundwater pretreatment system to the City of Cranston POTW may be delayed;

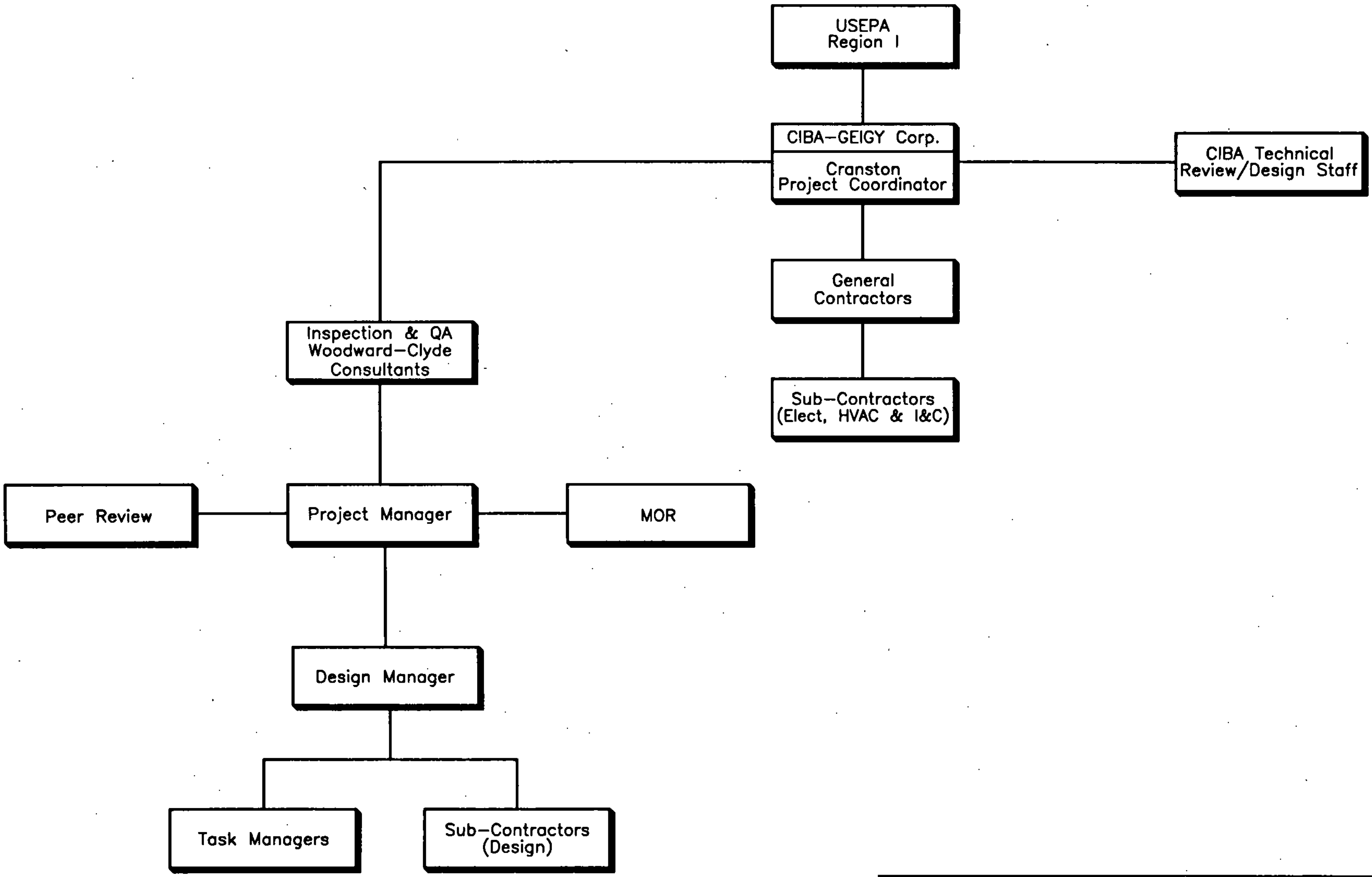
2. other permits or approvals required for stabilization activities may be refused or delayed; and

3. equipment procurement, delivery, and/or construction may be delayed.

Two critical success factors have been identified based on experience at the site:

1. vendor-supplied equipment must be delivered on schedule; and
2. contractor-performed construction must be completed on schedule.

Activities performed during the stabilization investigation will continue to be discussed in the Monthly Progress Reports. The Stabilization Report(s) will be prepared and submitted after the performance standards have been met.




PROJECT ORGANIZATION
STABILIZATION IMPLEMENTATION PHASE

**WOODWARD-CLYDE CONSULTANTS**

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

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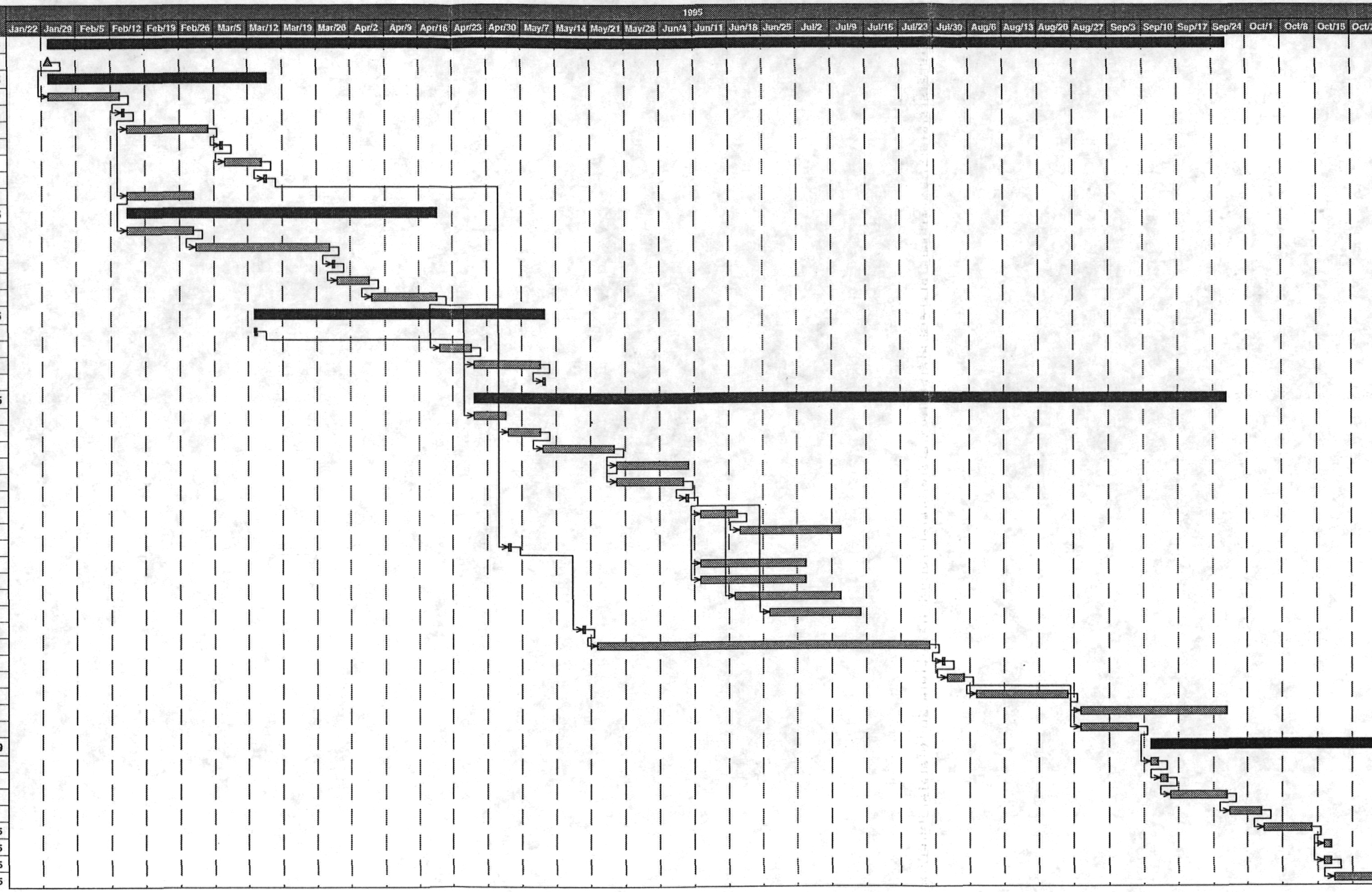
Figure 6-2
Schedule to Implement Stabilization

| Task Name | Duration In Days | Start Date | End Date |
|---|---|---|---|
| **SCHEDULE to IMPLEMENT STABILIZATION** | **172.0d** | **1/30/95** | **9/26/95** |
| Submit FSDD to USEPA | | 1/30/95 | 1/30/95 |
| **1. PREPARE BID PACKAGES** | **33.0d** | **1/30/95** | **3/15/95** |
| Develop Pre-Bid Packages | 11.0d | 1/30/95 | 2/13/95 |
| Submit Pre-Bid Packages for Quote | 1.0d | 2/14/95 | 2/14/95 |
| Vendors Develop Quotes for Bid | 13.0d | 2/15/95 | 3/3/95 |
| Ciba Receives Pre-Bid Quotes | 1.0d | 3/6/95 | 3/6/95 |
| Ciba Evaluates Quotes | 6.0d | 3/7/95 | 3/14/95 |
| Ciba Orders Pre-Bid Items | 1.0d | 3/15/95 | 3/15/95 |
| Develop Final Construction. Package | 10.0d | 2/15/95 | 2/28/95 |
| **2. SELECT CONTRACTORS** | **46.0d** | **2/15/95** | **4/19/95** |
| Pre-Qualify Construction Firms | 10.0d | 2/15/95 | 2/28/95 |
| Advertise Construction Package | 20.0d | 3/1/95 | 3/28/95 |
| Receive Construction Bids | 1.0d | 3/29/95 | 3/29/95 |
| Evaluate Construction Bids | 5.0d | 3/30/95 | 4/5/95 |
| Award Construction Contract | 10.0d | 4/6/95 | 4/19/95 |
| **3. ADDRESS PERMITTING ISSUES** | **44.0d** | **3/13/95** | **5/11/95** |
| Receive POTW Discharge Permit | 1.0d | 3/13/95 | 3/13/95 |
| Complete/Submit Construction Permits | 5.0d | 4/20/95 | 4/26/95 |
| City Reviews Constuction Permits | 10.0d | 4/27/95 | 5/10/95 |
| Receive Approved Construction Permits | 1.0d | 5/11/95 | 5/11/95 |
| **4. MOBILIZE, CONSTRUCT, and OPERATE** | **109.0d** | **4/27/95** | **9/26/95** |
| Mobilization | 5.0d | 4/27/95 | 5/3/95 |
| GC Develops Shop Drawings | 5.0d | 5/4/95 | 5/10/95 |
| GC Submits Shop Drawings | 11.0d | 5/11/95 | 5/25/95 |
| Ciba/WCC Approve Shop Drawings | 11.0d | 5/26/95 | 6/9/95 |
| GC Procures Equipment | 10.0d | 5/26/95 | 6/8/95 |
| GC Starts Construction | 1.0d | 6/9/95 | 6/9/95 |
| Perform Demolition Work | 6.0d | 6/12/95 | 6/19/95 |
| Complete Existing Wells | 15.0d | 6/20/95 | 7/10/95 |
| Ciba Receives Pre-Bid Items | 1.0d | 5/4/95 | 5/4/95 |
| Install Groundwater Forcemains | 16.0d | 6/12/95 | 7/3/95 |
| Install City Water Line | 16.0d | 6/12/95 | 7/3/95 |
| Install Gas Service | 16.0d | 6/19/95 | 7/10/95 |
| Install Electrical Service | 15.0d | 6/26/95 | 7/14/95 |
| Pre-Bid Items Arrive At Site | 1.0d | 5/19/95 | 5/19/95 |
| Equipment Installation | 50.0d | 5/22/95 | 7/28/95 |
| Complete Construction | 1.0d | 7/31/95 | 7/31/95 |
| CG Develops Punch List | 4.0d | 8/1/95 | 8/4/95 |
| GC Performs Punch List Work | 15.0d | 8/7/95 | 8/25/95 |
| Develop Record Drawings | 22.0d | 8/28/95 | 9/26/95 |
| System Start-Up and Testing | 10.0d | 8/28/95 | 9/8/95 |
| **5. BEGIN AQUIFER TESTING** | **34.0d** | **9/11/95** | **10/26/9** |
| Develop Existing Wells | 2.0d | 9/11/95 | 9/12/95 |
| Perform Step Drawdown Tests | 2.0d | 9/13/95 | 9/14/95 |
| Perform 72-Hr. Constant Rate Test | 8.0d | 9/15/95 | 9/26/95 |
| Evaluate Field Test Data | 5.0d | 9/27/95 | 10/3/95 |
| Install Additional Wells (if required) | 8.0d | 10/4/95 | 10/13/95 |
| Develop New Wells | 2.0d | 10/16/95 | 10/17/95 |
| Perform Step Drawdown Tests | 2.0d | 10/16/95 | 10/17/95 |
| Perform 72-Hr. Constant Rate Test | 7.0d | 10/18/95 | 10/26/95 |



## APPENDIX A
## WELL CONSTRUCTION DETAILS:
## GROUNDWATER CAPTURE SYSTEM
## SOIL VAPOR EXTRACTION SYSTEM

This appendix presents the construction details for the groundwater recovery wells and soil vapor extraction wells. Up to four recovery wells will be installed at the bulkhead for the groundwater capture system (refer to Drawing G-2 of Volume 4). The soil vapor extraction system will include seven wells at SWMU-11. Four wells are designed to recover soil vapor and groundwater; three wells are designed to recover groundwater only.

The conceptual design of the groundwater capture system is based on the results of the aquifer testing program that was performed as part of the pre-design field activities. Data from the testing program are presented in the Stabilization Investigation Report and Design Concepts Proposal (May 3, 1993). The groundwater capture system is designed to limit the migration of groundwater into the Pawtuxet River by reversing the hydraulic gradient along the bulkhead in the Production Area. The soil vapor extraction system design is based on the results of the HIVAC pilot test (also discussed in the Stabilization Investigation Report and Design Concepts Proposal) and its ability to remove constituent mass from both the soil and groundwater at SWMU-11.

Section A.1 presents the construction details for existing groundwater recovery wells (PW-110 and PW-120) that were installed in the Production Area during the summer of 1993. Section A.2 presents the strategy for installing additional groundwater recovery wells and their proposed construction details. Section A.3 presents the construction details for the soil vapor extraction wells.

### A.1. WELL CONSTRUCTION DETAILS FOR EXISTING GROUNDWATER RECOVERY WELLS

The groundwater capture system will include up to four recovery wells (PW-110, PW-120, PW-130 and PW-140) located 15 to 25 feet from the bulkhead (Figure A-1). Two of these wells

(PW-110 and PW-120) were installed during the field activities conducted in July of 1993. Additional recovery wells (PW-130 and PW-140) may be installed (if needed), after aquifer testing of PW-110 and PW-120 is completed. Figure A-2 presents the design of the existing recovery wells. Figure A-1 shows the location of this cross-section.

Recovery wells PW-110 and PW-120 were constructed as described in (Section 2.4.1) the Stabilization Investigation Report and Design Concepts Proposal. Soil borings were advanced at the selected well locations. Soil was sampled continuously from split-spoon samplers and logged; boring logs were presented in the DSDD. Soil sampling, drilling, and well installation activities were performed as described in the Quality Assurance Documents: Supplement (January 1992).

Selected split-spoon soil samples were analyzed in the field for grain size using 3-inch sieves. The results of the grain size analyses, were used to design the required sand pack and select the screen slot size for each well. The selected sand packs and screen slot sizes are shown in Figures A-3 and A-4 for recovery wells PW-110 and PW-120, respectively.

The recovery wells were designed to reverse the hydraulic gradient at the bulkhead with the minimum drawdown required. By minimizing the required drawdown, the potential for drawing contaminants vertically downward into less contaminated deeper units is reduced greatly. A description of each recovery well design is presented here:

**PW-110:** Recovery well PW-110 is constructed in the Fill, Gravelly Sand, and Fine Sand units (Figure A-2). These three units were determined to be fully hydraulically connected (when one unit is pumped, a drawdown response is noted in the other units) during aquifer testing. To create a cone of depression that extended into the boundaries of the Gravelly Sand unit, PW-110 was installed at a depth of 35 feet below ground surface, a depth that can sustain a constant pumping rate of greater than 40 gpm.

PW-110 does not create a pathway for the migration of constituents into the deeper Fine Sand unit. PW-110 does not penetrate a confining or semi-confining unit (the Silt unit is absent here as shown in Figure A-2) and the flow induced from the pumping of PW-110 will be horizontal within the aquifers, not vertically.

**PW-120:** Recovery well PW-120 is constructed in the Fill, Silt, and Fine Sand units (Figure A-2). To attain the minimum drawdown goals (10 gpm or more) along the southwest portion of the bulkhead, PW-120 had to be installed deep enough to sustain a constant yield. Based on the results of aquifer testing for RC-2, PW-120 was installed at a depth of 45 feet below ground surface.

PW-120 was constructed with two screened intervals (in the Fill unit and in the Fine Sand unit; see Figures A-2 and A-4) to limit the potential for the downward migration of constituents. The Silt unit is cased off to minimize the potential for the downward migration of constituents along the borehole (Figure A-2).

It should be noted that contamination in the deeper Fine Sand unit has been detected in the area of PW-120. This is based on the 48 foot deep Hydropunch sample in boring P-2D which is reported in the Stabilization Investigation Report and Design Concepts Proposal. As such, PW-120 will not cause a new migration pathway into the Fine Sand unit. PW-120, as constructed, will prevent further degradation and aid in constituent removal in the Fine Sand unit at this location.

## A.2 PROPOSED ADDITIONAL GROUNDWATER RECOVERY WELLS

Up to two additional recovery wells (PW-130 and PW-140) may be required along the bulkhead if the drawdown from PW-110 and PW-120 is not sufficient to reverse the hydraulic gradient along the bulkhead. These wells are proposed at the approximate locations shown on Figure A-1. The need for one or two additional recovery wells will depend on the areal extent required and the amount of space along the central portion of the bulkhead where this gradient reversal is required.

The construction of PW-130 and PW-140 will be limited in depth to the bottom of the Fill unit as shown in Figure A-5. This construction is proposed so that a pathway for constituents is not introduced into the Fine Sand unit (which is essentially uncontaminated in these areas). However, this proposed construction does limit the areal extent of the cone of influence that will be attained by either PW-130 and PW-140.

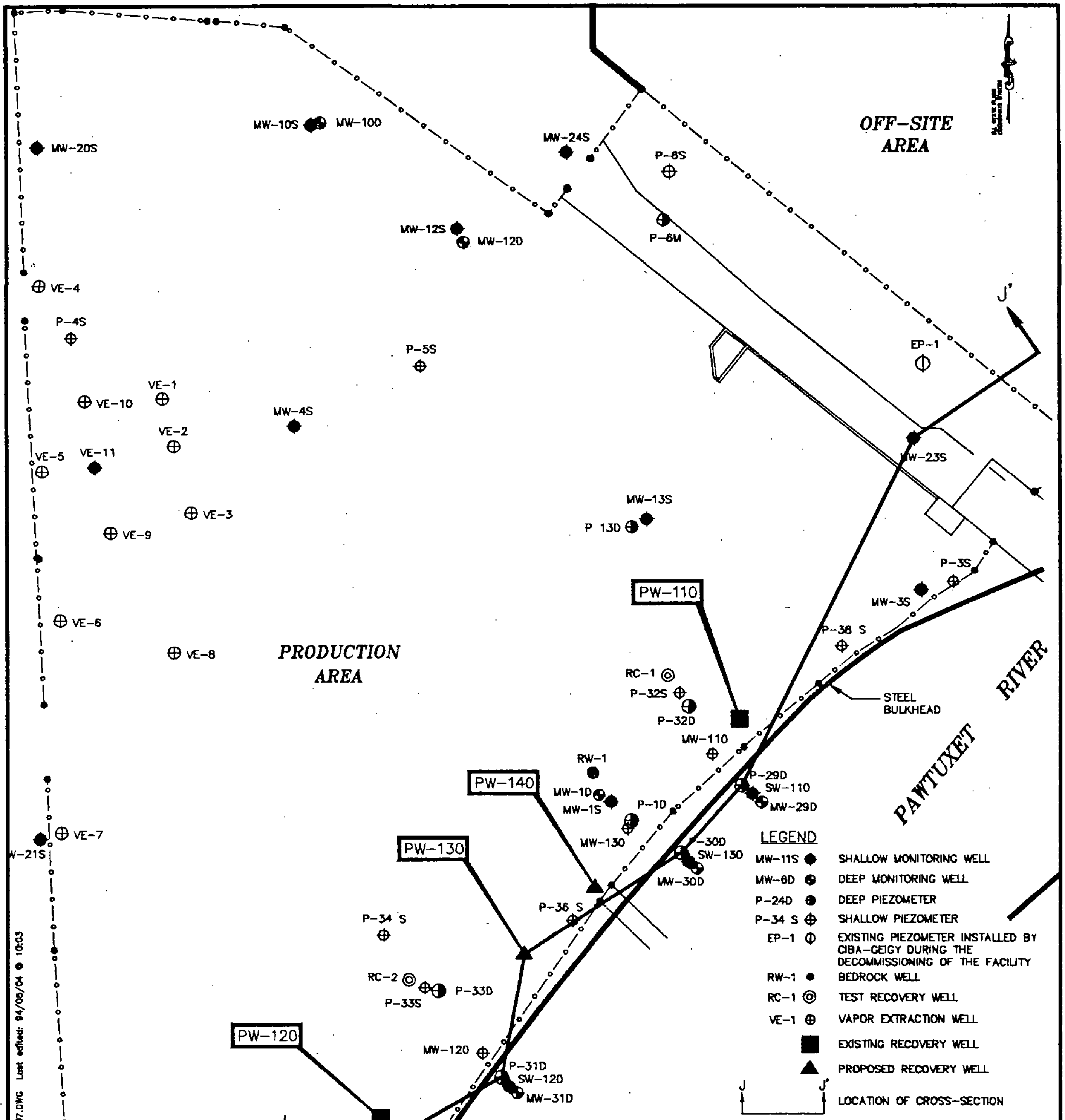
## A.5 SOIL VAPOR EXTRACTION WELL CONSTRUCTION DETAILS

Seven extraction wells (VE-1, VE-2, VE-3, VE-7, VE-9, VE-10, and VE-11) are proposed for the SVE system. Four of these wells (VE-1, VE-2, VE-3, and VE-11) will extract soil vapor and groundwater. Three wells (VE-7, VE-9, and VE-10) will extract groundwater only. Six monitoring wells (VE-4, VE-5, VE-6, VE-8, MW-4S, and P-4S), which could be converted to soil vapor and/or groundwater extraction wells if needed, are also part of the SVE system.

Wells VE-2, VE-4, VE-5, VE-6, VE-7, VE-8, VE-9, and VE-10 were installed at a depth of 20 feet below the ground surface. These wells were constructed of 15-feet, 4-inch diameter 0.010 inch slotted PVC screen and 6-feet, 4-inch diameter PVC riser pipe. Each well contains about 16 feet of Morie #00 sand, a 1-foot bentonite seal, and is completed with a cement/bentonite mixture to the ground surface. VE-1 and VE-3 are constructed in the same manner but are finished with 2-inch diameter PVC. The soil vapor extraction wells are constructed with the screened interval at least 2 feet above the water table to maximize vapor recovery. Well screens generally extend through the entire saturated portion of the Fill unit.

VE-2 and VE-3 are located in an area containing free floating product (which was not discovered until after the wells were constructed). Since this product contains mostly toluene which degrades the integrity of PVC, it may be necessary to replace VE-1 and VE-2. Also, since VE-3 is only 2-inches in diameter, (not wide enough to fit the SVE system controls), it is also necessary to replace VE-3. These wells will be replaced by VE-1R, VE-2R, VE-3R (to be constructed within 3 feet of VE-1, VE-2, and VE-3). The replacement wells will be constructed of stainless steel to minimize the potential for the degradation of the PVC due to the presence of free product. Other construction details are the same as previously described.

The other wells in the SVE system, VE-11 (formerly MW-14S), MW-4S, and P-4S were installed as monitoring wells during Phase I field activities. Their construction details are presented in the RCRA Facility Investigation Interim Report (November 20, 1991).

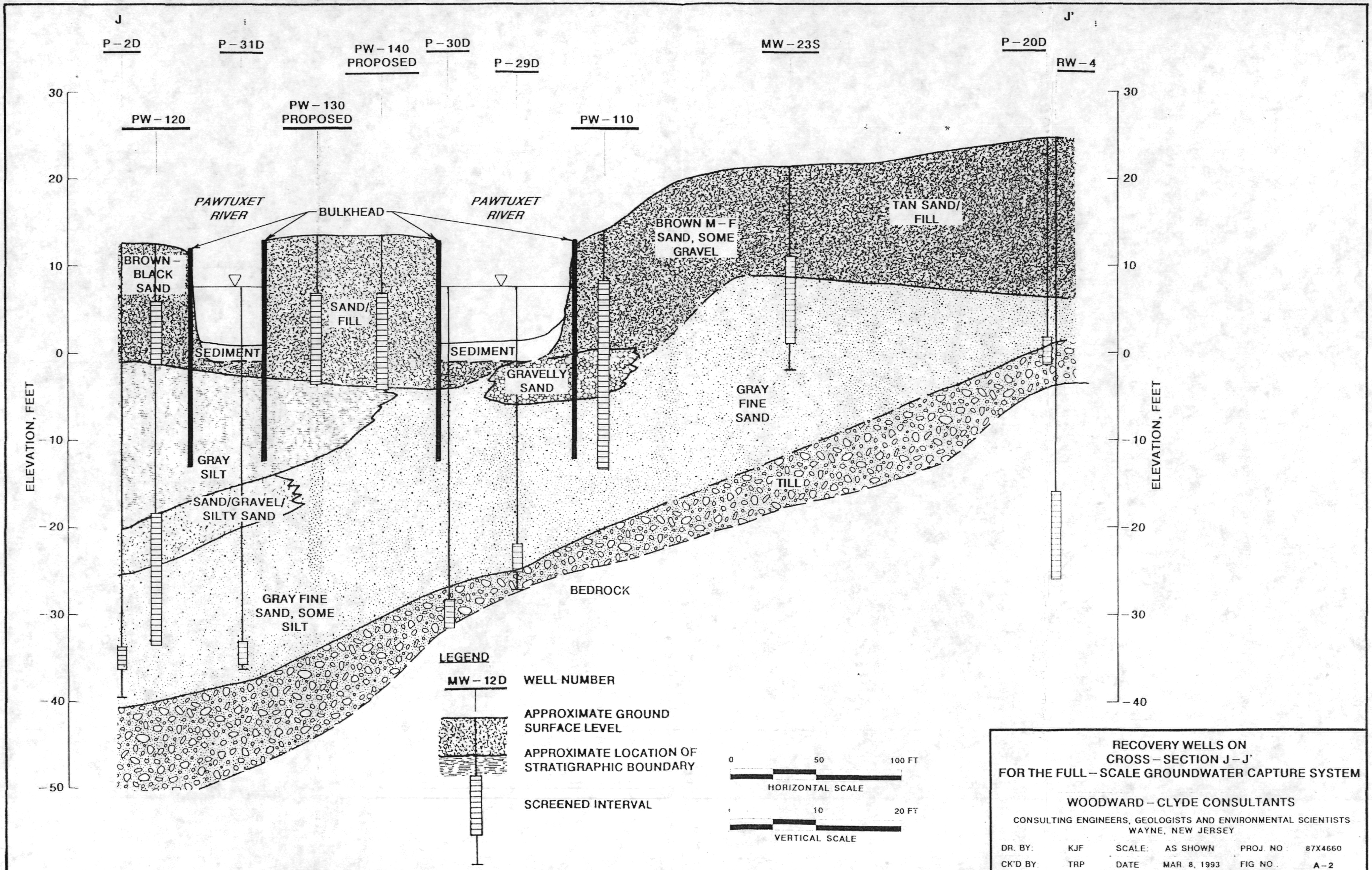



PROPOSED RECOVERY WELL LOCATIONS FOR THE FULL-SCALE GROUNDWATER CAPTURE SYSTEM

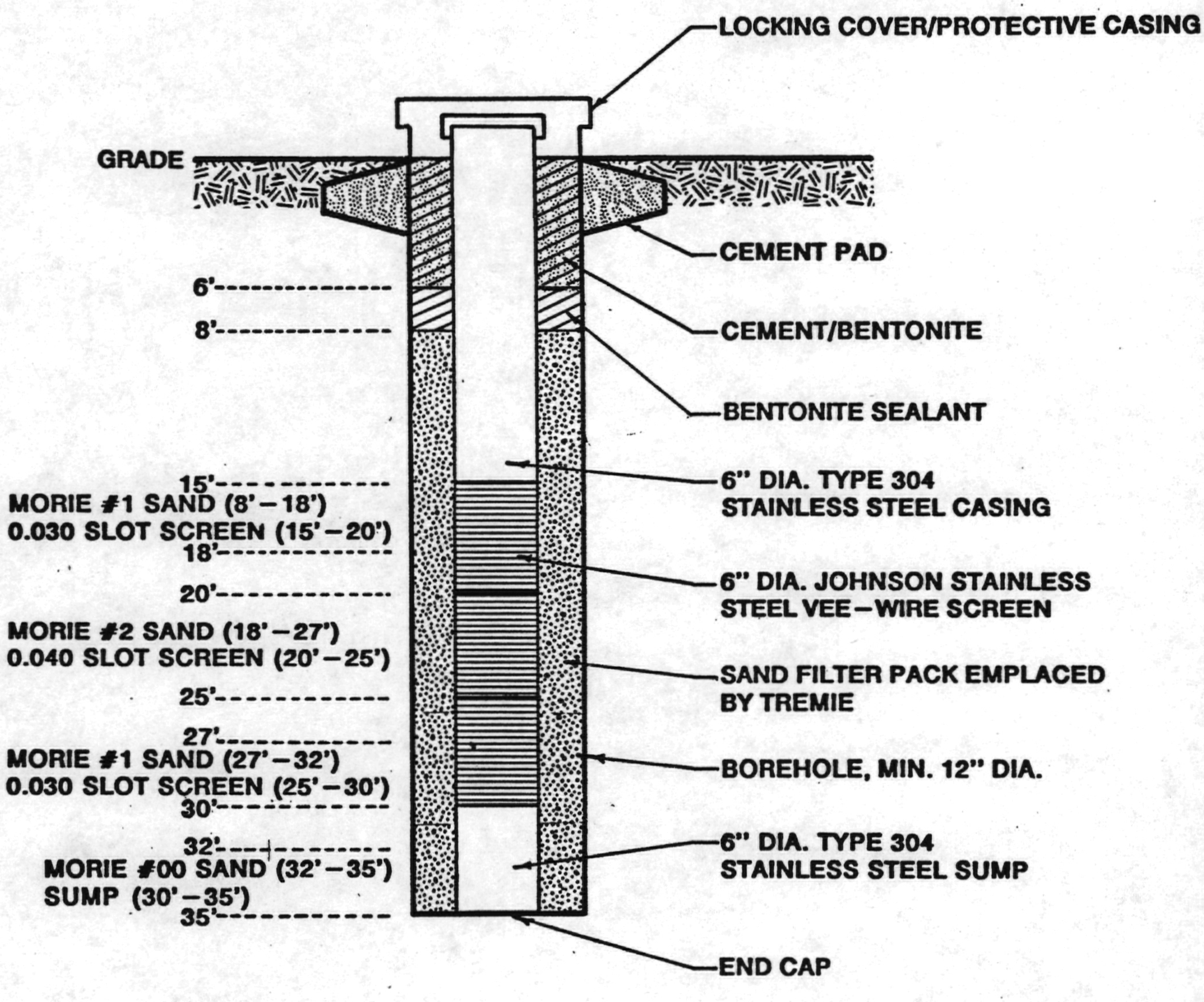
**WOODWARD-CLYDE CONSULTANTS**

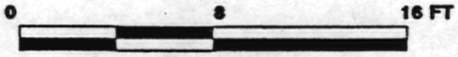
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DR.BY | MVB | SCALE | 1:720 | DWG.NO. | 74660007 | PROJ. | 87X4660 |
| CK'D.BY | KAK | DATE | MAY 4, 1994 | | | FIG.NO. | A-1 |


J
J'
P-2D
P-31D
PW-140
PROPOSED
P-30D
P-29D
MW-23S
P-20D
RW-4
PW-120
PW-130
PROPOSED
PW-110
PAWTUXET
RIVER
BULKHEAD
PAWTUXET
RIVER
BROWN M-F
SAND, SOME
GRAVEL
TAN SAND/
FILL
BROWN-
BLACK
SAND
SAND/
FILL
SEDIMENT
SEDIMENT
GRAVELLY
SAND
GRAY
FINE
SAND
GRAY
SILT
SAND/GRAVEL/
SILTY SAND
TILL
BEDROCK
GRAY FINE
SAND, SOME
SILT
ELEVATION, FEET
30
20
10
0
-10
-20
-30
-40
-50
LEGEND
MW-12D
WELL NUMBER
APPROXIMATE GROUND
SURFACE LEVEL
APPROXIMATE LOCATION OF
STRATIGRAPHIC BOUNDARY
SCREENED INTERVAL
0
50
100 FT
HORIZONTAL SCALE
10
20 FT
VERTICAL SCALE
RECOVERY WELLS ON
CROSS-SECTION J-J'
FOR THE FULL-SCALE GROUNDWATER CAPTURE SYSTEM
WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY
DR. BY: KJF
SCALE: AS SHOWN
PROJ. NO. 87X4660
CK'D BY: TRP
DATE: MAR. 8, 1993
FIG NO. A-2

# WELL CONSTRUCTION DETAILS (AS BUILT)
## PW-110




VERTICAL SCALE

HORIZONTAL NOT TO SCALE

WELL CONSTRUCTION DETAILS PW-110

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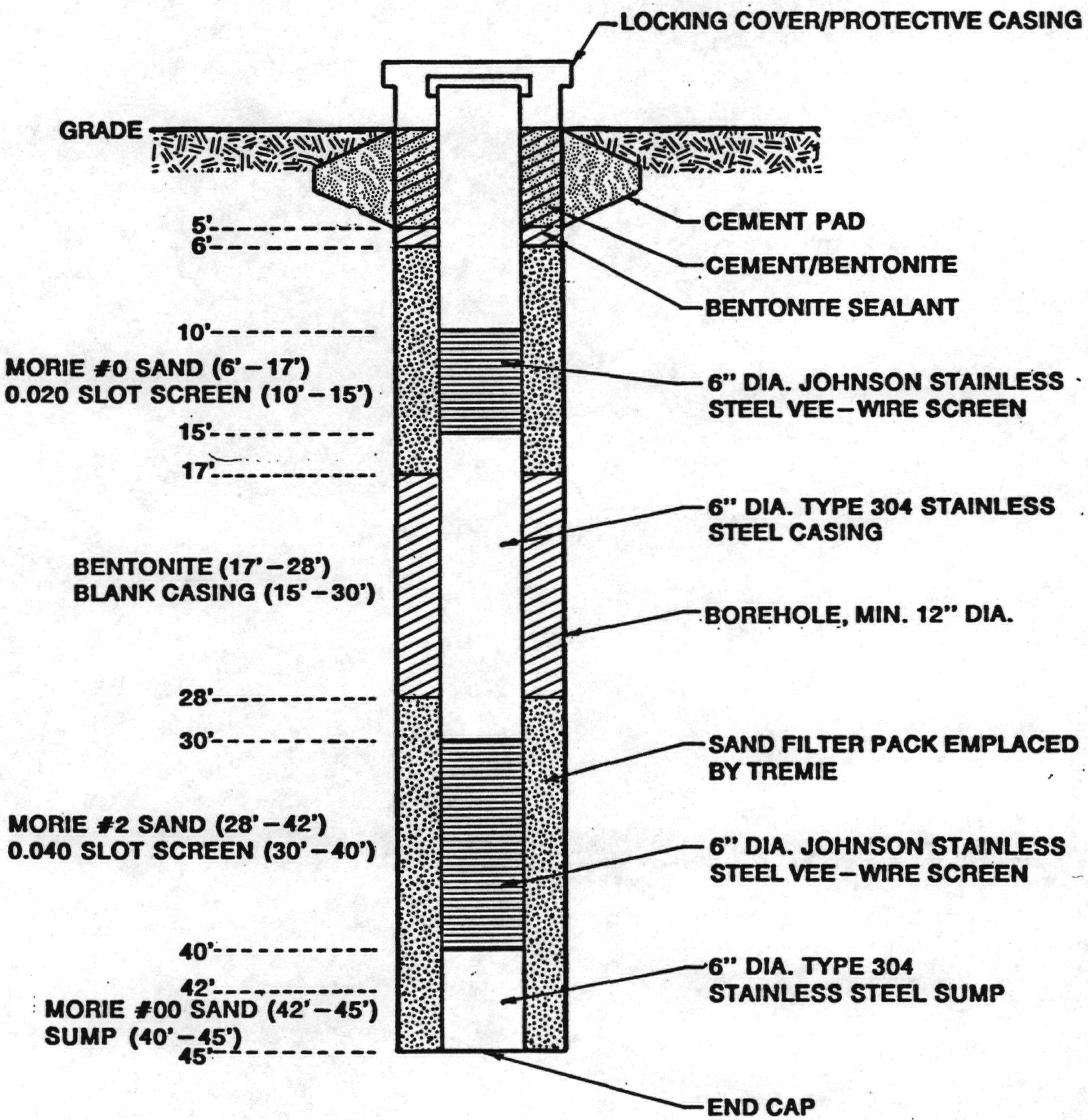
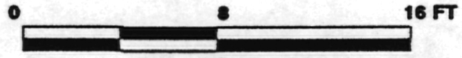
| DR. BY: | KJFH | SCALE: | AS SHOWN | PROJ. NO.: | 87X4660 |
| CK'D BY: | TRP | DATE: | OCT. 25, 1993 | FIG. NO.: | A-3 |

# WELL CONSTRUCTION DETAILS (AS BUILT)
## PW-120




VERTICAL SCALE

HORIZONTAL NOT TO SCALE

WELL CONSTRUCTION DETAILS PW-120

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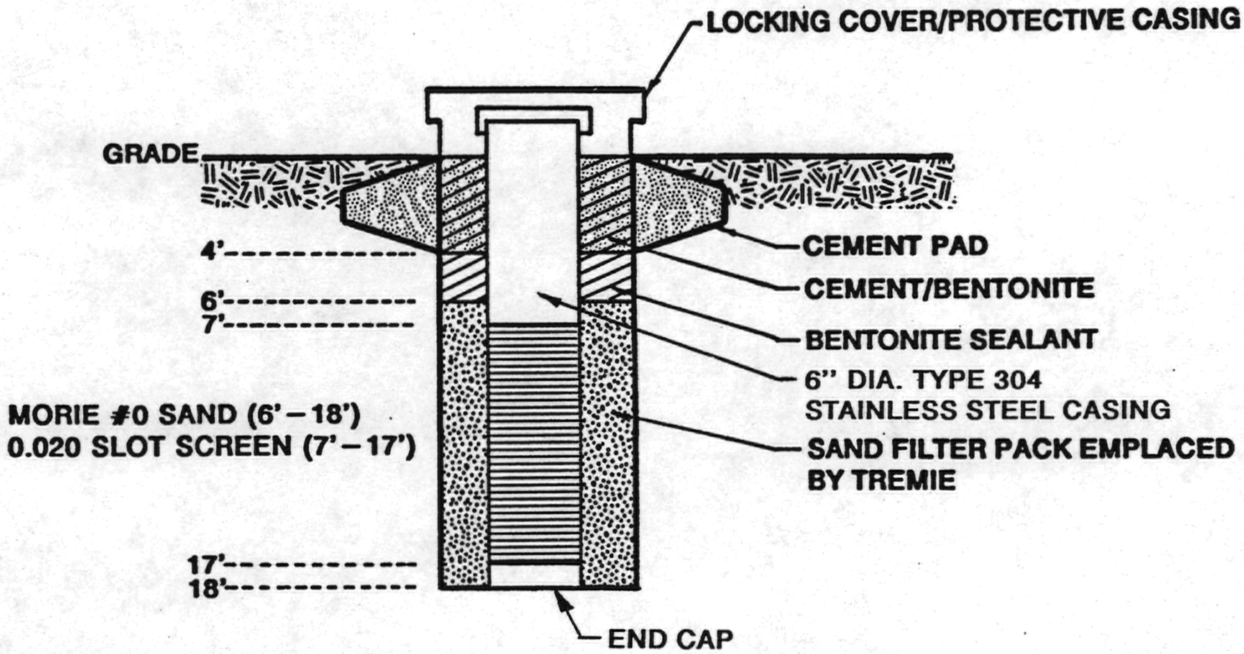
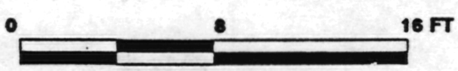
| CK'D BY: | TRP | DATE: | OCT. 25, 1993 | FIG. NO.: | A-4 |

# WELL CONSTRUCTION DETAILS (PROPOSED)
## PW – 130 and PW – 140




VERTICAL SCALE

HORIZONTAL NOT TO SCALE

PROPOSED WELL CONSTRUCTION DETAILS

PW – 130 AND PW – 140

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|---|---|---|---|---|---|
| DR. BY: | KJFH | SCALE: | AS SHOWN | PROJ. NO.: | 87X4660 |
| CK'D BY: | TRP | DATE: | OCT. 25, 1993 | FIG. NO.: | A–5 |